PETROLEUM PROCESSING

including Petrochemical Processing Section

FEBRUARY 1953

Modern Refining in Mexico

The first in a series of articles on the Mexican petroleum industry—p. 217

Clean Exchanger Tubes in Place

You get faster cleaning, more time on stream, better heat transfer—p. 228

Your Corrosion Engineer

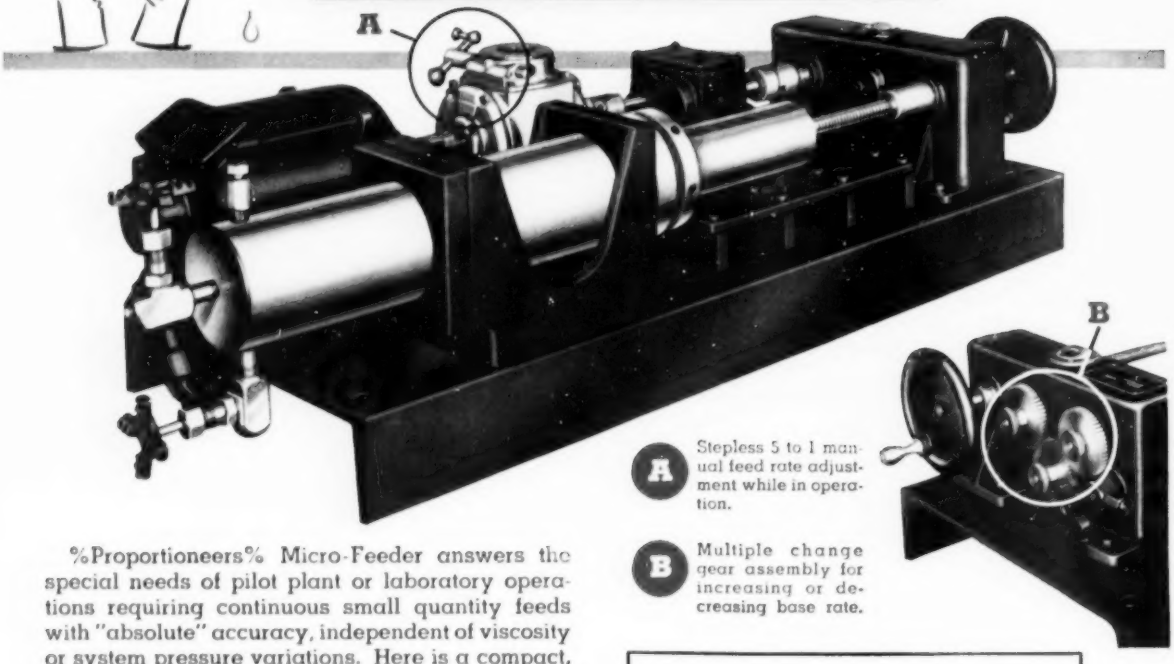
What are his attributes—his duties—what results can you expect?—p. 230

OXO Process—Status Today

Activities grow in the use of this route to petrochemicals from olefins—p. 241

FOR MICROMETER ACCURACY IN FLUID FEEDING

AT CONSTANT RATE OR FLOW PROPORTIONALLY



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We put 30 years of work into this pin

You've seen plenty of service pins. You may wear one yourself indicating five, ten, twenty-five years of service with your company.

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We believe this thirty years of experience is one of the most important ingredients in Ethyl antiknock service. For while one pound of antiknock compound may be very much like another—its value to the refiner depends largely on how it is used. From the very beginning, Ethyl has had as its principal objective not

(*Continued on next page*)

ETHYL
ETHYL CORPORATION

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We put 30 years of work into this pin

(Continued from preceding page)

only the efficient manufacture of a product, but the development of services which would help our customers get the most out of that product.

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Ethyl service is backed by 30 years of antiknock experience

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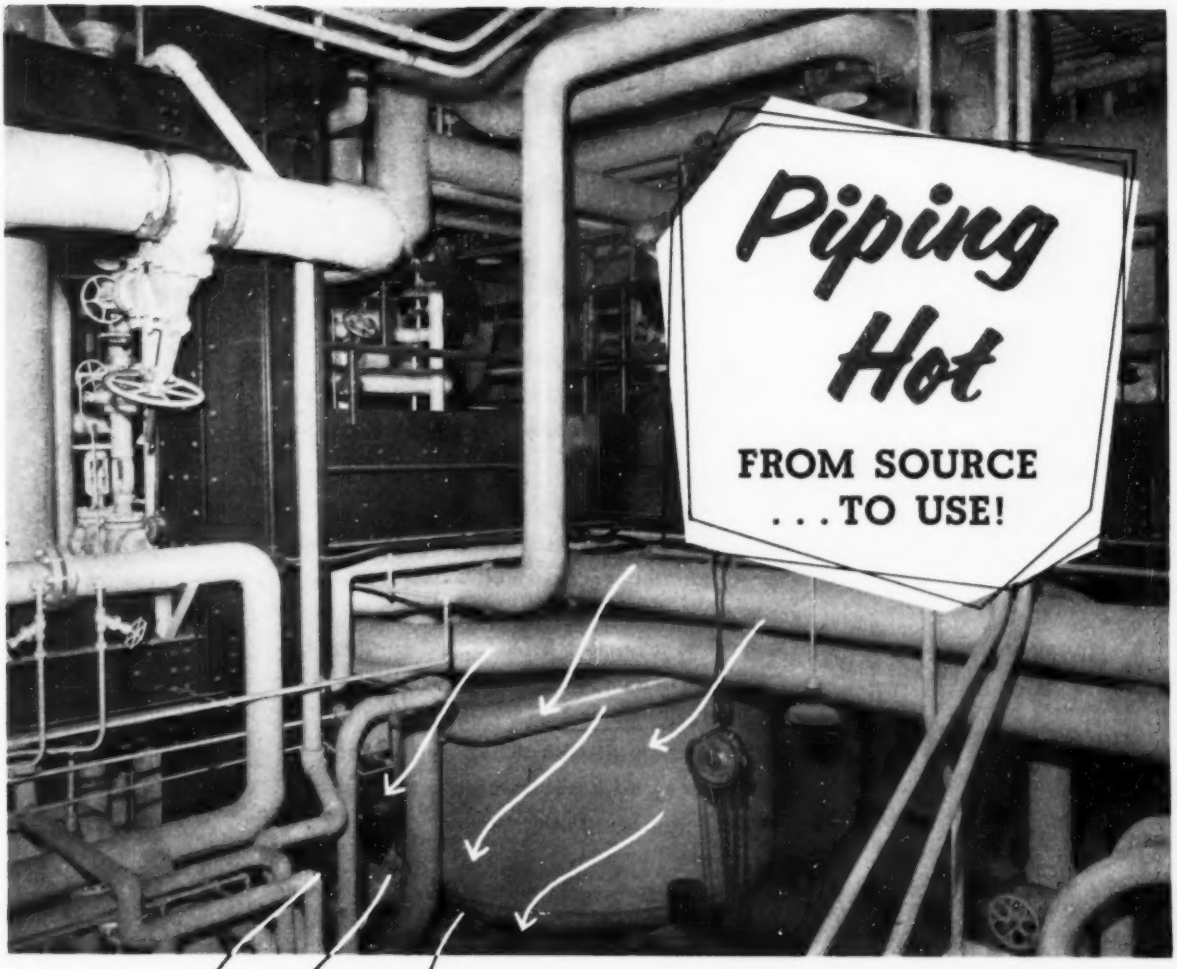

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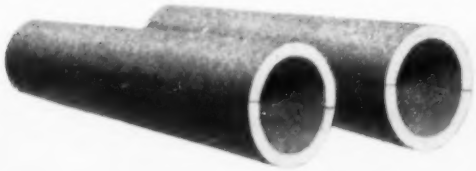

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That's why you're finding more Unibestos in more plants every day. It's made in cylinders and half-rounds in two types: No. 750 for temperatures up to 750°F.; No. 1200 for up to 1200°F. And it's also available in block-form for up to 1200°F. uses.

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(To obtain more data on advertised products see page 280)

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Here are the Floating Roof Specifications which 30 years' experience has shown are necessary for best performance.

1. **Well designed, close fitting Seals; including Primary, Secondary, and Top Seals for maximum conservation.**
2. **Pontoons divided into large number of GAS-TIGHT compartments for safety.**
3. **Pontoon compartments Deep and Roomy so they may be easily entered and inspected for maintenance if necessary.**
4. **Pontoon compartments uncluttered with framework for easy inspection and maintenance.**
5. **COMPLETE CLEAN Drainage.**
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PETROLEUM PROCESSING

Covering petroleum research and the design, management, operation and maintenance of plants processing hydrocarbon materials into fuels, lubricants and chemicals

February, 1953
Vol. 8, No. 2

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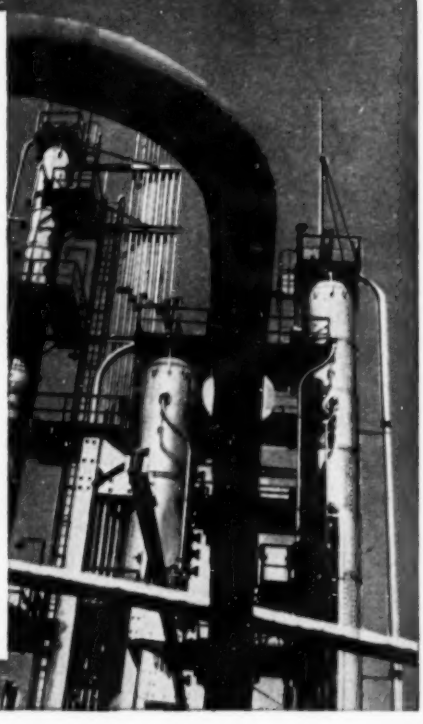
in processing vessels WITH

METEX

MIST ELIMINATORS



The unusually high efficiency with which these *knitted* wire mesh units remove the liquid entrainment that occurs in a wide variety of refining and processing operations has enabled engineers to:

1. Improve product quality and eliminate reruns.
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3. Recover valuable products previously lost.
4. Operate existing equipment at higher capacities.
5. Design new equipment with smaller dimensions.
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KNOCK-OUT DRUMS	SCRUBBERS	STEAM DRUMS

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Write for bulletins giving detailed information — including limiting velocities, pressure drop, efficiencies, etc.

METAL TEXTILE CORPORATION

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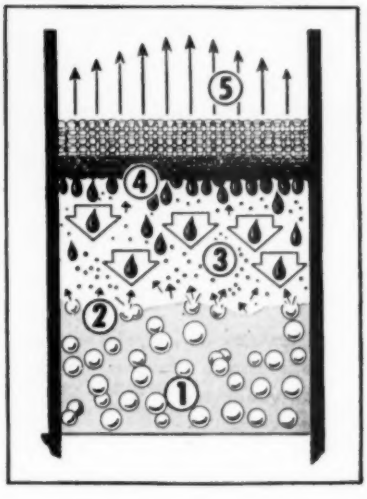
Main Office & Plant, Roselle, New Jersey Canadian Plant, Hamilton, Ont.

PADS OF KNITTED WIRE MESH WIPE OUT LIQUID ENTRAINMENT

Pads of uniform density, made from multiple layers of knitted wire mesh, have proved exceptionally effective in removing liquid entrainment from gases in a wide range of refining and processing operations.

The pad is placed inside a vessel above the liquid level. Its construction provides a multiplicity of unaligned, asymmetrical openings with unusually large wire-surface area. It is impossible for a gas to pass through the pad without continually changing direction; yet the high free volume—97 to 98%—minimizes restriction and pressure drop.

METHOD OF OPERATION



When a gas is generated in or passes through a liquid (1), it carries with it, as it bursts from the liquid surface (2), a fine spray of droplets of entrained liquid. These droplets are carried upward by the rising gas stream (3).

As the gas passes through the pad, the droplets impinge on the extensive wire surface (125 square feet of area per cubic foot of pad volume). The droplets coalesce on the wire surface to form large drops of liquid which break away (4) from the wire mesh and fall back against the gas stream. The gas (5) passes on, freed from liquid entrainment.

AVAILABILITY

The pads, which are known as METEX Mist Eliminators are made by Metal Textile Corporation, 631 East First Avenue, Roselle, N. J. A bulletin giving detailed information is available on request from the manufacturer.

(*To obtain more data on advertised products see page* 280)

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Publisher's Page

Dave Brushed Up on His Spanish

A lot of information goes back and forth across the line between the U.S. and Canada about oil discoveries there, new refineries and petrochemical ventures. For many oil men in this country are closely concerned with these developments to the North. On the other hand, there is comparatively little accurate information in this country about the oil business, including refining, south of the border in old Mexico. Perhaps that is only natural, too, for after the Expropriation the American oil companies have been inclined to let Nature take its course there.

However, PETROLEUM PROCESSING writers, particularly in the Southwest, kept picking up interesting bits of information about what was going on in the oil business in Mexico. Some of it made sense, some did not. The testimonial dinner held in Dallas last March, in honor of Ex-Senator Antonio J. Bermudez—he stills runs Petroleos Mexicanos, which is the Mexican oil industry—looked like an important step in the direction of improving our international relations to the south. All-in-all, the time seemed right for a story on the oil business in Mexico, with emphasis on refining for PETROLEUM PROCESSING readers. Dave Thornton, our Southwestern Editor, drew the assignment and both he and his wife at once started brushing up on their limited Spanish, along with other necessary arrangements for the trip.

For seven weeks Thornton picked and poked and pried through the principal refineries in Mexico. The technologists and others he visited with were uniformly courteous and helpful, and always friendly. They went out of their way to make him feel at home in a new environment, escorted him around the plants when he asked, let him poke around alone when he preferred. They dug out charts, books and records; did their best to clear up perplexities. After a time, due more to similarity of terms than anything else, Dave even found he could read some of their engineering reports, albeit "muy pocito"—very little—and everyone got a good laugh out of some of the attempted translations.

The article in this issue (pg. 217) is the first of five stories Dave wrote from his trip into Mexico. We hope you enjoy reading them as much as Dave says he enjoyed getting the material and writing them. And if you get a few surprises in your reading, Dave says you will be following his own experience. He did not expect to find what he saw in the way of fine plants, the best of housekeeping and a fierce pride in achievement. Thornton is glad he made the trip, PETROLEUM PROCESSING is glad he made it, and if his articles serve to give our readers a better understanding of Mexico's petroleum problems, we will all be more than satisfied.

Virgil Guthrie

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The weekly oil marketing magazine, covering news, prices, transportation, storage, merchandising

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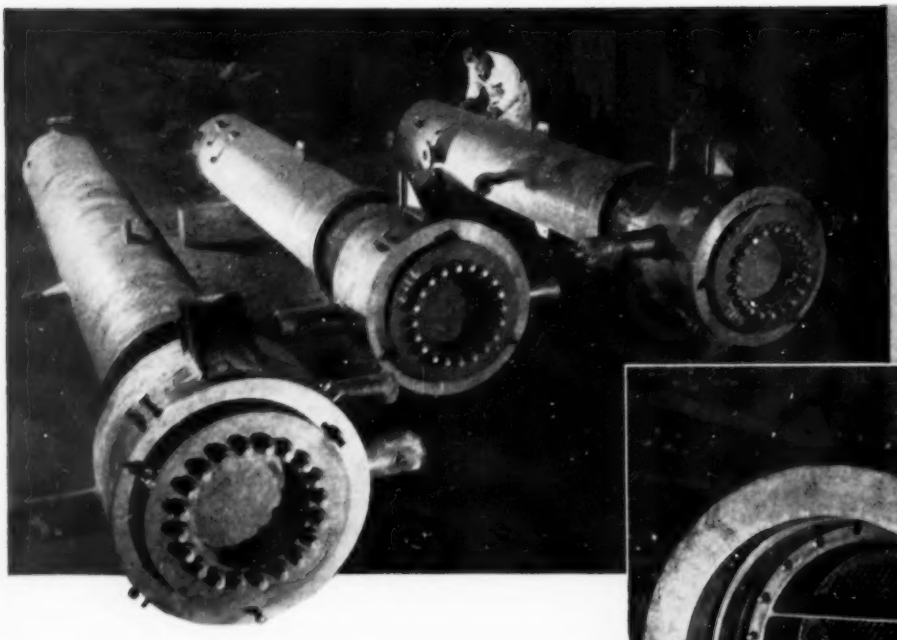
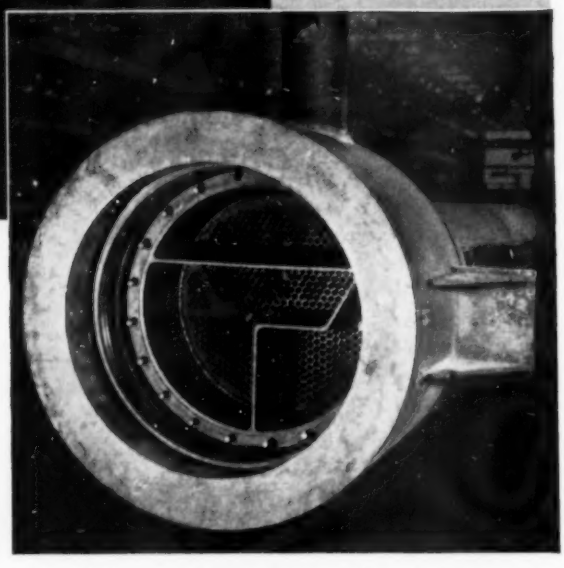
Platt's Oilgram Prices
A daily independent oil-price reporting service issued from New York, Cleveland and Houston



Industry comes to A. O. Smith with Heat Exchanger Problems



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Your best source for

HIGH-PRESSURE

Heat Exchangers

• Three high-pressure heat exchangers are shown in the upper illustration. They are designed for 2400 psi on the tube side and have modified Bridgeman closures for channel covers.

• The lower illustration is a view of one of the above heat exchangers prior to completion. It shows detail of channel construction. The tube sheet was drilled by an A. O. Smith high-precision method to a degree of perfection far above accepted standards, to insure against leakage.

• • •

Here, at A. O. Smith, is a matchless combination of designing, engineering and fabricating skills, experience and equipment on which to draw in solving any heat exchanger problem. Dedicated to the search and development of better techniques, A. O. Smith engineers have created many "firsts" in the pressure-vessel and heat-exchanger fields.

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Proof of performance is obtained with A. O. Smith's own testing procedures. Full-scale vessels are tested to destruction at isolated test stations where pressures up to 50,000 psi can be applied. Materials are tested prior to fabrication in the company's chemical, physical, metallurgical and spectrographic laboratories.

Problems are resolved by research groups whose combined experience and accumulated data are without parallel. Closely associated are the experts in tool and fixture design who have their own unexcelled facilities.

For high-pressure or conventional heat exchangers, whether for chemical, petro-chemical, petroleum refining or power applications, A. O. Smith is your best source.

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What's Happening . . .

Refinery Expansion

. . . **Esso Standard Oil Co.** has commenced construction on modernization program at its 135,000 b/d Bayway, N. J., refinery, to be completed by mid-1954. New units include 60,000 b/d two-stage pipe still which will increase net plant throughput 16,000 b/d, a 20,000 b/d hydrofiner and high viscosity fuel burning system. Hydrofiner, first of its type to be built, supplants current method of refining gasoline and heating oil with sulfuric acid and has separate reactors for the two materials. Aside from fact that process was developed by Standard Oil Development Co. and no further details concerning it have been made available.

. . . **Pacific Oil & Refining Co.** faces construction delay on its Tacoma, Wash., refinery ("What's Happening," Jan. '53, p. 7) since PAD cannot grant any steel allotment until third quarter. Pacific wanted initial 83 tons in second quarter, out of total of almost 2800 tons. Application for rapid tax amortization on 10,000 b/d plant is still pending.

. . . **Shell Oil Co.** is dusting off plans to build a $75 million refinery in Puget Sound area providing Washington state law forbidding land ownership by aliens is amended. Company said site and plant capacity have not been settled.

. . . **Standard Oil, Co. (Ind.)** expects to start construction of its new 30,000 b/d refinery at Mandan, N. Dak. in late Spring (See "What's Happning," Sept. '52, p. 1215; Feb. '52, p. 127). Lummus Co. has been selected as prime contractor and project is scheduled for completion in Oct. '54. Feature of plant will be combination of crude topping, Fluid catalytic cracking, vapor recovery and polymerization into a continuous process.

. . . **Standard Oil of California** plans to invest more than $30 million this year in new refinery facilities, according to Chairman of the Board R. G. Follis. New facilities, Follis said, "will enable us to turn out, among other things, more aviation gasoline and the ingredients for petrochemicals."

. . . **Ingram Products Co.** is enlarging and revamping its refinery near New Orleans to include catalytic cracking, polymerization, and vacuum distillation. Capacity of all units, when modernization is complete, will be 7000 b/d. Procon is contractor, with completion scheduled for Jan. 1, '54.

. . . **Socony-Vacuum Oil Co.** plans to build a new catalytic polymerization unit at its E. St. Louis, Ill. refinery, and to double naphtha reforming capacity through conversion of an existing thermal cracking coil—both projects in addition to the new 15,000 b/d TCC airlift unit announced last month (see "What's Happening," Jan. '53, p. 7). Construction of the new units is to start in the third quarter.

. . . **Aurora Gasoline Co.** will install a 1500 b/d UOP Platforming unit at its Elsie, Mich. refinery, with construction being handled by Procon, Inc.

. . . **Pure Oil Co.** has awarded contract for building additional boiler house facilities and other auxiliaries at its Toledo, Ohio refinery to Catalytic Construction Co. Work is part of major expansion program now underway at the Toledo plant (see "What's Happening," Feb. '52, p. 127).

. . . **Standard Oil Co. (Ind.)** expects construction to start late this summer on new 700 b/d sulfuric acid alkylation unit at its Casper, Wyo. refinery, with initial operation scheduled for May '54. M. W. Kellogg Co. is prime contractor.

. . . **Pana Refining Co.** has started a 2-year modernization program at its 4400 b/d refinery at Pana, Ill., to cost an estimated $900,000. Program will include a 650 b/d type "A" Platformer, and revamping of present facilities to increase capacity to 6000 b/d. Procon has construction contract for Platformer, with refinery staff planning to do other work.

Petrochemicals

. . . **A new process for making cold synthetic rubber** in a continuous stainless steel pipeline has been developed by B. F. Goodrich Chemical Co. The process uses an extremely active catalyst which cuts the reaction time to 15 to 20 min., as compared with the 10 to 12 hr. now required with conventional pressure vessels. Goodrich engineers estimate that investment costs for a new plant using the "pipeline" process would be at least 50% less than a conventional plant. The new process cannot be used in existing GR-S plants.

. . . **Shortage of butylenes** is cutting into supply of petroleum-based butadiene for synthetic rubber and has resulted in reactivation of two alcohol butadiene plants which Reconstruction Finance Corp. has had in standby status. Plants being put back into service are at Louisville, Ky. (operated by Union Carbide & Carbon Corp.) and at Kobuta, Pa. (operated by Koppers Co.).

. . . **Allied Chemical & Dye Corp.** is already thinking about expanding its still-to-be-built ammonia-urea fertilizer plant at La Platte (Omaha), Nebr. Start of construction on plant has been held up pending FPC approval of Allied's contract for natural gas (see "What's Happening," Nov. '52, p. 1543). Company spokesman recently revealed that Omaha plant may some day be as large as other Allied ammonia installations at Hopewell (five ammonia trains) and South Point (three trains).

. . . **Shell Chemical Corp.'s** new marketing division, Julius Hyman & Co., has found office space so scarce in Denver that the firm leased an ultra-modern hotel. A "no vacancy" sign has been posted to discourage would-be lodgers.

Information on these pages is obtained through the nation-wide news coverage service of PLATT'S OILGRAM NEWS

. . . **Dow Chemical Co.,** long a major producer of ethylene glycol, is now packaging permanent-type antifreeze under customers' private-brand labels, and has set up a new Organic Chemicals Sales section to handle its merchandising.

Industrial Mobilization

. . . **Activities of Petroleum Administration for Defense** may be taken over by Commerce Dept. when and if general controls program is reduced to skeleton form, according to Washington observers. PAD presently is organized under Secretary of Interior, and indications are that new Interior Secretary McKay is not particularly interested in retaining PAD within his department. His attitude is said to be that of wanting Interior to resume "normal" functions as quickly as possible. Timing hasn't been determined, but it may take place by mid-year.

. . . **Alkylate facilities** may get an increase in rate of rapid tax write-off to 100% in an effort to overcome industry's natural reluctance to build such facilities because of fear of sharp drop in demand. Current rate generally permitted in 90%, but official of Defense Production Administration has indicated that agency would approve PAD request to increase this to 100%. Facilities already approved at 90% rate might be allowed 100% write-off.

. . . **Supplies of aviation gasoline** will remain tight at least until mid '54, according to study made by PAD's Military Fuels Technical Advisory Committee. Shortage for next year and a half will continue about 6,000 to 10,000 b/d.

. . . **Current picture on tubular heat exchangers** is this: Order backlogs run from four to nine months; inventories are slightly lower than last fall, with some spot shortage; manufacturers are finding it hard to get heavy plate and seamless pipe. Situation was revealed when exchanger manufacturers told National Production Authority they need to know more about needs of oil and other expansion programs if they are to be expected to meet upcoming demands.

. . . **PERSONNEL—R. Rea Jackson** (Socony-Vacuum) has replaced **William W. Keeler as** deputy director of PAD's Refining Division . . . **Paul E. Kuhl** (Esso Standard Oil) has replaced **W. Vaughn Ischie** as director of the Foreign Refining Division . . . **Howard S. Spering** (Texaco Development Corp.) has been appointed asst. director (refining economics) of the Refining Division.

Markets, Prices

. . . **Further easing in the supply situation** on most products in refinery and terminal districts east of the Rocky Mountains was indicated during the first month of 1953. With the possible exception of distillate fuels at the Gulf, buyers had no trouble in obtaining requirements needed to supplement their contract commitments. Some items, and notable heavy fuel oils along the Atlantic Seaboard and lubricating oils generally, were downright weak.

. . . **Residuals were down** at East Coast terminal points in amounts ranging up to 11c a bbl. for Bunker "C", with New York harbor price at $2.00 a bbl. The downward move in posted prices, touched off by Esso Standard on Jan. 16, did not indicate any further rise in inventories at the U.S. Gulf or in the Caribbean area, but resulted indirectly from the sharp decline in rates for ocean transportation.

Lower East Coast prices for residuals posted last August reflected a general weakening in the primary supply markets. Since that time, charter rates for dirty tankers from the Caribbean area have declined $1.01 a ton, or roughly 15c a bbl.

. . . **In lubricating oils,** it was a matter of the market becoming a "dog eat dog" proposition virtually overnight, according to trade reports. Increased lube oil refining capacity abroad has made deep inroads on the export market, and inventories in this country consequently have risen to the burdensome point.

Pennsylvania bright stock was down 3c a gal. to 25c toward the end of January. Solvent refined oils in the Mid-Continent were quoted 1c lower with bright stock at 25c, 200 vis. neutral at 15.5c, FOB Tulsa basis, and solvent bright at the Gulf Coast dropped 2.5c to 24c, FOB ship.

. . . **Natural gasoline prices dipped** 0.5c a gal.—about a month earlier than breaks from winter levels in the past three years. The mild weather to date had much to do with reduced demands for natural for winter motor fuel blending.

Refined gasoline prices were steady, but supplies were readily available in virtually all areas.

Miscellany

. . . **Foreign lube oil capacity** will reach 76,600 b/d by Jan. 1, '54, according to survey by PAD, and will include 44,800 b/d of solvent and 31,800 b/d of conventional capacity. This compares with capacity of 58,000 b/d (28,000 solvent and 30,000 conventional) as of Jan. 1, '52.

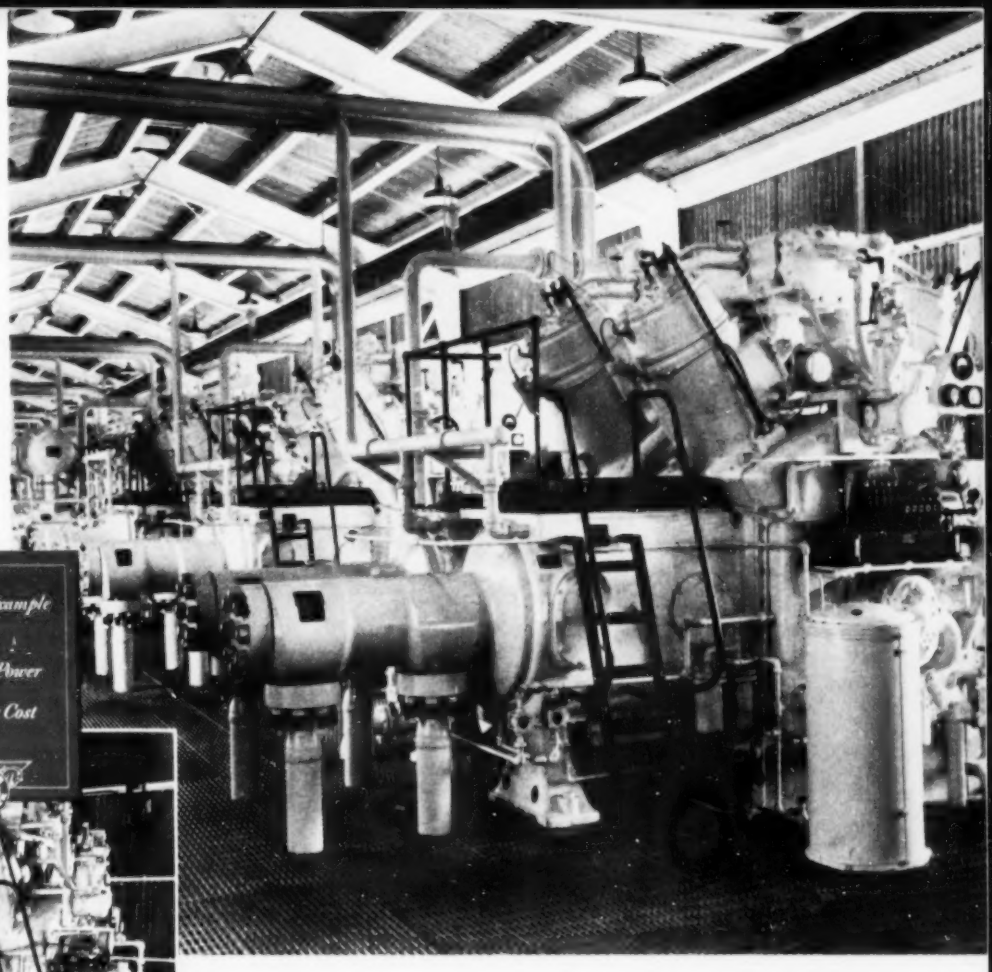
. . . **Peace on the oil labor front** is the expectation this year. Observers who should know are of opinion that there will be a minimum of oil labor trouble this year, with virtually no indication that 1952 strikes will be repeated. Oil Workers International Union reportedly this year plans to put emphasis on organization and other internal union problems.

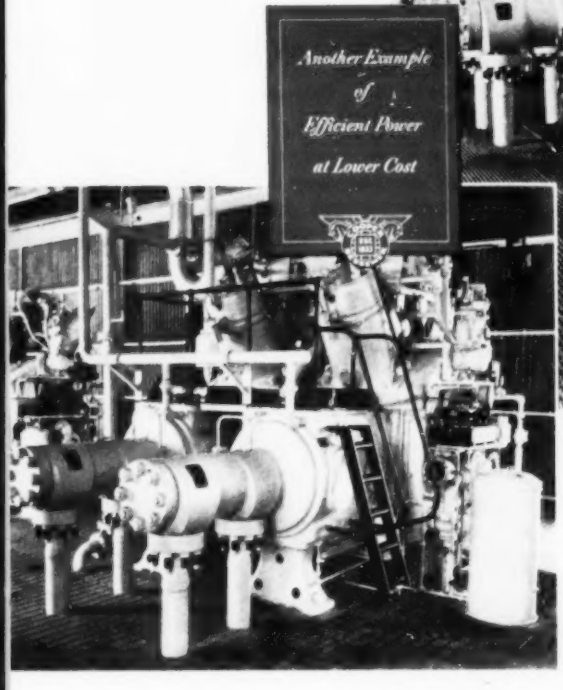
. . . **Octane rating requirements** for regular-grade gasoline for shipment in Great Lakes Pipe Line will be increased one full number to 84 beginning Mar. 2, according to Midwest refiners. Maximum lead content allowed will remain at 2 cc.

. . . **Turkish Institute of Minerals Prospecting** has signed agreement with Ralph Parsons Co. calling for construction of a 6000 b/d refinery in southeastern Turkey at a cost of about $7 million. Plant will take two years to build, following which it will be operated for the first year by U.S. specialists and then taken over by Turkish government.

6300 hp line-up of GMV-10 and GMV-4 V-angle compressors in a large Texas synthetic ammonia plant. GMV-4 recirculator units are in foreground, GMV-10 process units in background.

Close-up of high pressure compressor cylinders on one of the GMV-4 units in recirculator service — first application of its kind.





THEY COUNT ON THESE GMV's *for smooth operation in high-pressure service!*

IN this Texas synthetic ammonia plant, these modern, reliable Cooper-Bessemer GMV's help in a big way to keep the process running smoothly. For example, GMV flexibility permits effective, dependable automatic control — set in this case to maintain constant suction pressure.

The compressor line-up consists of seven GMV's. Two are recirculator units — the *first* 2-cycle gas engine compressors to be used for such service. The other five are GMV-10 process units compressing a hydrogen-nitrogen mixture, through 5 stages, from 2 psig to 5300 psig.

Here, in Texas, this same company operates *fifty-four additional* GMV's in 4 light hydrocarbon plants — plenty of experience to know that GMV quality and features pay off. In fact, Cooper-Bessemer V-angles are doing a real job in many a chemical and petrochemical plant . . . offering installation and operating economies seldom if ever matched.

The
Cooper-Bessemer
Corporation

MOUNT VERNON, OHIO — GROVE CITY, PENNA.

New York City Washington, D. C. Bradford, Pa. Parkersburg, W. Va.
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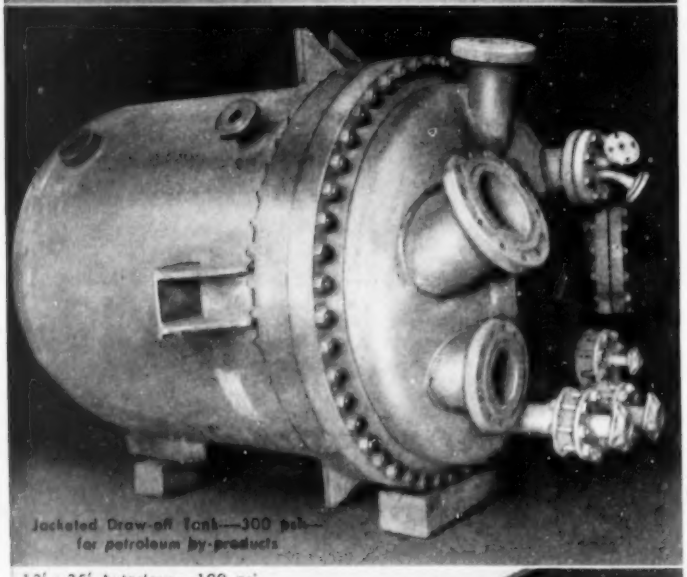
Caracas, Venezuela Gloucester, Mass. Tulsa, Okla. New Orleans, La.

It's GRAVER for pressure vessels and code work!

Two Quench Pots 3' x 21' 6"—35 psi—
for petrochemicals



Jacketed Draw-off Tank—300 psi—
for petroleum by-products

Processing plants today increasingly require specially designed pressure vessels. Graver has long been expert in the fabrication of code vessels, whether API-ASME, ASME or even more stringent specifications set by customers. Graver-built pressure equipment assures long life and safe, dependable service.

The steady flow of steel, clad and alloy pressure vessels through Graver's plants is suggested by these shop views. They indicate the many skills and services obtainable through Graver's high standards of welding craftsmanship.

GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA

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DETROIT • CINCINNATI • CATASAUQUA, PA.
HOUSTON • SAND SPRINGS, OKLA.

12' x 35' Autoclave—100 psi
—for rubber

GRAVER

Titanium May Be Your Solution to Critical Corrosion Problems

IN THE heart of downtown Detroit last month a billboard proclaimed: "Titanium—'The Wonder Metal'—Forged by Kropp." Meanwhile, across the street at the Sheraton-Cadillac hotel, the Society of Automotive Engineers was listening to a symposium of six papers on the same subject—Titanium.

Together, the billboard and the symposium speakers told a story—of the availability and properties of a material which until a year ago was classed as a rare engineering metal along with tantalum, tungsten and zirconium.

According to one of the symposium speakers,[1] only 10 tons of titanium were produced in 1948, yet last year an estimated 1000 tons were produced—a 100-fold increase. New production capacity now authorized and being planned will raise that figure to about 10,000 tons.

Major demand for commercial production of titanium has come from the aircraft industry, where the strength-to-weight ratio of titanium alloys is an important factor. The pure metal has a density of 4.55, or 0.163 lb./cu. in.—only slightly more than half the density of steel and about 1.5 times as heavy as aluminum. The most common grade of commercially pure, unalloyed titanium has a typical yield strength of 80,000 psi. and 90,000 psi. ultimate; commercially available alloys have strengths about double these values.

But the metal has another property which is of even more importance to the petroleum processing industries — corrosion-resistance. In chemical environments titanium is not appreciably attacked by nitric acid, wet chlorine, chloride salts, organic acids, sulfur and sulfur compounds, and strong alkalis. (On the other hand, there is appreciable attack by dry chlorine, hydrochloric, sulfuric, phosphoric and hydrofluoric acids.)

Services in which increasing application of titanium are expected include "industrial applications in which titanium's particular corrosion resistance can be utilized" and ". . . equipment in which a combination of light weight, corrosion resistance, high strength and/or intermediate temperature properties are required."

On the matter of temperature resistance, another speaker[2] brought out that "titanium-base alloys offer excellent properties for application to temperatures of at least 550° C. (1020° F.)" and that "some of these alloys show better creep rupture properties at this temperature than types 304 and 403 stainless steel."

Titanium products are now available in essentially all of the standard wrought mill forms in which stainless steel is available, with new forms and larger pieces becoming available as demand develops.

Sheet and plate are available in thickness from 0.016 in. to 1 in., in widths up to 48 in. and in lengths up to 140 in.

Strip up to 12 in. wide is available, and widths up to 36 in. are under development on continuous mills.

Welded tubing in sizes from ¼-in. O.D. up, with wall thicknesses up to 0.125 in., can be furnished in straight lengths 10 to 15 ft. long.

Hammered forgings can be furnished as rounds, squares, flats, discs, rings, billets and simple shapes, with maximum weight limited only by ingot size—presently 4000 lbs.

There's just one drawback—price. Wrought forms cost between $10 and $20/lb. Even with that obstacle, however, if you have a critical corrosion problem somewhere in the plant which has you stumped, it might pay you to take a look at titanium.

—W.F.B.

(1) "The Bases for Tonnage Titanium Production," by C. I. Bradford, pre ented at SAE 1953 annual meeting, Detroit, Mich., Jan. 12-16, 1953.

(2) "Titanium Alloy Development," by M. Hansen and H. D. Kessler, presented at SAE 1953 annual meeting, Detroit, Mich., Jan. 12-16, 1953.

Barrier to Our Chemicals Trade with Canada

THE importance to the free nations of the world of the Canadian chemical and allied industries is brought out in a paper by the president of Shawinigan Chemicals Ltd., Montreal, presented before the Synthetic Organic Chemical Manufacturers Assn. of the U.S.[1] To this position the petrochemical industry in Canada, more in its infancy even than in the U.S., is contributing greatly.

Canada's chemical industries showed a total production value in 1951 of $759,000,000, double the 1946 figure and five times the prewar high of $159,000,000 in 1939. For the past 20 years the chemical industry there has had an average growth rate of 11% per year, compared to 4.1% for all industries.

The chemical industry in 1952 invested some $122,000,000 in new developments. This was approximately 12% of the total capital expenditures by all manufacturing industries. In capital outlay, the chemical industry ranked third, after iron and steel products with $171,000,000 and paper products with $147,000,000. The reasons for the great growth of the chemical industry in Canada is assigned to:

1—Replacement of natural products by synthetic materials.

2—Availability of new basic raw materials.

3—Technological advances due to research findings.

The petrochemical industry in Canada is only about 10 years old, but its capital investment in plants built, under construction and announced, is $173,000,000. Table 1, from the report by Shawini-

Table 1—Capital Investment in Canadian Petrochemical Plants, and Their Products, Including Recent and Projected Developments

WESTERN CANDA	SARNIA DISTRICT	MONTREAL DISTRICT
Investment	**Ivestment**	**Investment**
$54,000,000	$78,000,000	$41,000,000
Products	**Products**	**Products**
Ammonia	Synthetic Rubber	Ethylene Glycol
Ammonium Nitrate	Ethylene Glycol	Phenol
Oxygenated Hydrocarbons	Chlorinated Solvents	Acetone
	Methyl Chlorides	Isopropanol
Polyethylene	Ethyl Chlorides	Formaldehyde
Sulfur	Styrene	Pentaerythritol
	Furnace Black	

gan, shows the investment in the three districts of Western Canada, Sarnia and Montreal and the principal products made in each district. While the new oil and gas fields in Western Canada are recognized as providing a huge potential for chemicals, "Alberta will not be another Texas, for it is too far removed from markets in eastern Canada, with no tidewater available."

An even greater handicap to the Canadian petrochemical industry is seen in the present high tariff protection which U. S. chemical producers enjoy. The geographical position of the two countries, the similarity of the tastes of their peoples, and their present joint defense effort against Russia and her captive nations, the Canadian chemical producers believe, should lead to greater tariff concessions for their products. —V. B. G.

(1) "A Survey of the Chemical Industry in Canada", V. G. Bartram, president, Shawinigan Chemicals Ltd., Montreal, before Synthetic Chemical Manufacturers Assn. of the U. S., New York, N. Y., Jan. 14, 1953.

Spectrographic Oil Analysis for Diesel Locomotive Maintenance

IN A cooperative program of the American Locomotive Co. and several railroads, the spectrograph is being used for analyzing Diesel engine lubricating oils in use, to detect and prevent serious engine trouble. The work is reviewed in a report on a two-day symposium held at Schenectady to evaluate the program.(1)

While the program is relatively new some idea of its scope can be seen from the fact that, since September, 1951, Alco has sampled 1325 locomotives for 23 different railroads, a total of 7157 samples being taken. The company is currently obtaining samples from 850 locomotives twice a month, in cooperation with more than 20 railroads.

Many difficulties were naturally encountered in working out, on this scale, techniques for diesel lube oil analysis which could be interpreted in terms of engine wear, but much progress has already been made. The tests must be reasonably rapid to be of service for engine maintenance purposes, and of a type which can be used at servicing points rather than entirely in central laboratories. The methods had to provide for identifying additive metals placed in the oils by their manufacturers, as well as establishing what concentrations of certain metals indicated abnormal engine operation or excessive wear. Experiments are now being made with liquid samples in place of ash, to expedite the work.

In its method of test, Alco uses lithium carbonate as a calibration standard, since there is nothing in their Diesel engines made of lithium. Six elements are determined spectrographically to evaluate engine conditions. Lead and copper are indicated for bearing conditions. Iron is the indicating element for detecting unusual conditions in many engine parts. Chromium is both an indicator of liner wear and also of water leaks, since Diesel engines in railway service use water treated with chromate for cooling. Aluminum shows up trouble in the aluminum pistons and silicon is an indicator for dirt, particularly airborne dirt.

In connection with the spectrographic analysis, Alco uses the ASTM pentane insoluble test for physical analysis of the oil to indicate blow-by or combustion gases. Taken in conjunction with iron concentrations, excessive ring wear might thus be indicated.

The report by an Alco research and testing engineer states the use of the spectrograph has enabled the avoidance of serious engine breakdowns due to bearing difficulty, and has proved valuable in detecting corrosion of copper-lead bearings long before serious difficulty is experienced. The attitude of the railroad chemists and engineers towards the work can be summed up in the statement of the same technologist: "It is important that we look upon the spectrograph as a tool of great potential—not yet in a position to take the place of any present inspection and maintenance procedures."

The studies of the railroad group are contributing materially to the development of techniques for lubricating oil analysis by spectrograph, which may also prove of value to the oil companies and the automotive industry. —V.B.G.

(1) "Symposium on Spectrographic Analysis of Diesel Engine Lubricating Oil," May 5-6, 1952, Schenectady, N. Y.; published by the American Locomotive Co.

Rosin-Soap Threatens Use of Oil As Extender in Synthetic Rubber

ONE of the newest tricks in rubber extenders, now undergoing experimental commercial-scale runs, is the use of rosin-soap in the production of cold GR-S. In tests to date, the new formulation appears to have a 25 to 50% greater resistance to abrasion and therefore is of particular interest in long-life tire treads.(1) If this material proves practical, it may remove some of the emphasis on petroleum oils as extenders, providing the qualities imparted are enough better than the oil-extenders to compensate for rosin's higher cost.

The use of rosin in rubber is by no means new. It has long been known as an excellent plasticizer, both with natural and synthetic rubbers; also, it has been commonly used as an emulsifier during polymerization. But, heretofore, there has been little rosin in the finished rubber. The difference is that, when used as an emulsifier, the rosin amounts to 5 to 7 parts per 100 parts of synthetic rubber polymer; as an extender there are 15 to 100 parts of rosin per 100 parts of rubber.

Why rosin imparts additional abrasion resistance is not known. It acts like the petroleum oils in lubricating and softening the high molecular weight GR-S chains, thus making them easier to process and more manageable. But rosin also makes the rubber tougher and increases tensile strength.

Use of rosin-extenders will not involve any major changes in processing techniques; standard equipment handles the rosin-extended rubber without difficulty. Also, the common procedure of master-batching the required carbon black will not be interfered with when using rosin soap.

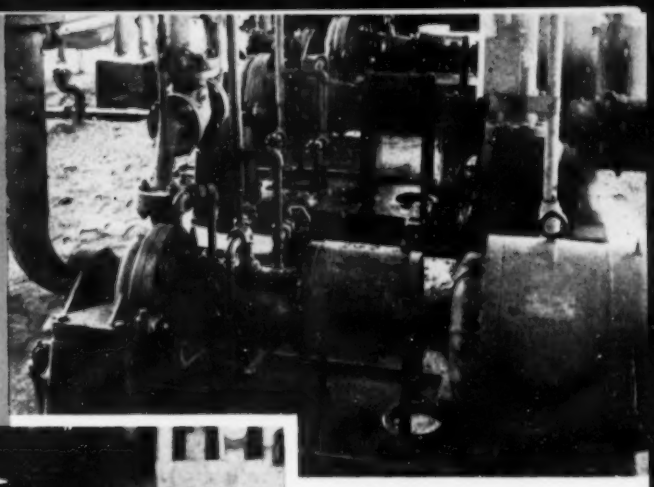
Cost-wise, petroleum extender-oils now are priced at approximately 2½c per lb.; rosin ranges from about 7½ to 15c a pound. So, for the present at least, the petroleum oils have the edge and the answer will not be known until a lot more evaluation tests have been run. —D.P.T.

(1) "Opportunity for Rosin," *Chemical Week*, Jan. 24, '53, p. 29-32.

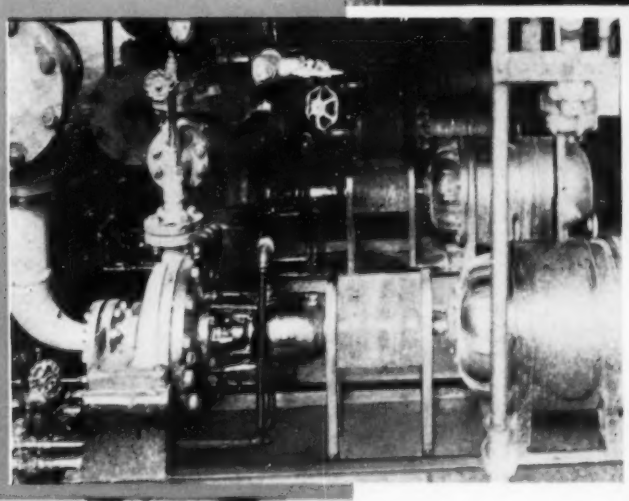
Pumping Jobs are Different...

but your maintenance inventories stay small, when you standardize on

Wilson-Snyder Type ES Process Pumps

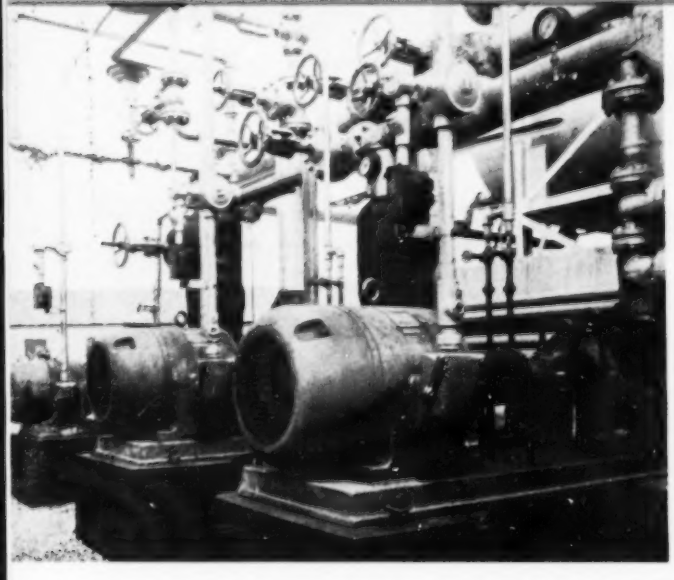


Three pumps are in the "Cat Cracker" feed preparation section. They handle gasoline with sp. gr. .742 at 100°F temperatures at differential pressures from 75 to 150 psi - yet each pump capacity is 137 gpm.



Three more pumps in service in the "Gas Recovery" section handle both gasoline with sp. gr. .581 and lighter and butane with sp. gr. .507 and lighter at the rate of 140 gpm and at pump temperatures of 130°F. Differential pressures for different pumps range from 75 to 185 psi.

These seven "product pumps" directly beneath the main "Cat Cracker" section handle hot oil at temperatures ranging from 400°F to 800°F. Pumps in the bank operate independently of each other and differential pressures range from 75 to 210 psi - capacities from 100 to 535 gpm.



GREAT LAKES Refining Division of Petco Corporation near Chicago, Illinois, has thirteen Type ES Centrifugal Process Pumps in three distinctly different process service applications—each of which presents different operating conditions and calls for different combinations of capacities, differential heads, specific gravities, etc. The description by each picture tells the story.

But what the engineers of this refinery discovered was this: In addition to the broad capacity range at high efficiency and the extra long service life provided in the Type ES pump design . . . only three sizes of bearing brackets, sleeves, packings, shafts and bearings are required for servicing all 18 pump sizes in the line.

This enables refineries to standardize on these pumps for most types of operations where capacity ranges are from 40 to 1800 gpm, with differential heads from 40 to 1000 feet, with speeds ranging from 1750 to 4000 rpm and with horsepower ranges from 2 to 250. Extra savings result from the amazingly small inventory of maintenance supply parts required.

FOR FULL INFORMATION . . . or quotations on Wilson-Snyder Process Pumps, contact "Oilwell's" nearest refinery specialist at area office points shown at left.

OIL WELL SUPPLY DIVISION
UNITED STATES STEEL CORPORATION

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Export Office—
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Area Offices — CALGARY, CANADA
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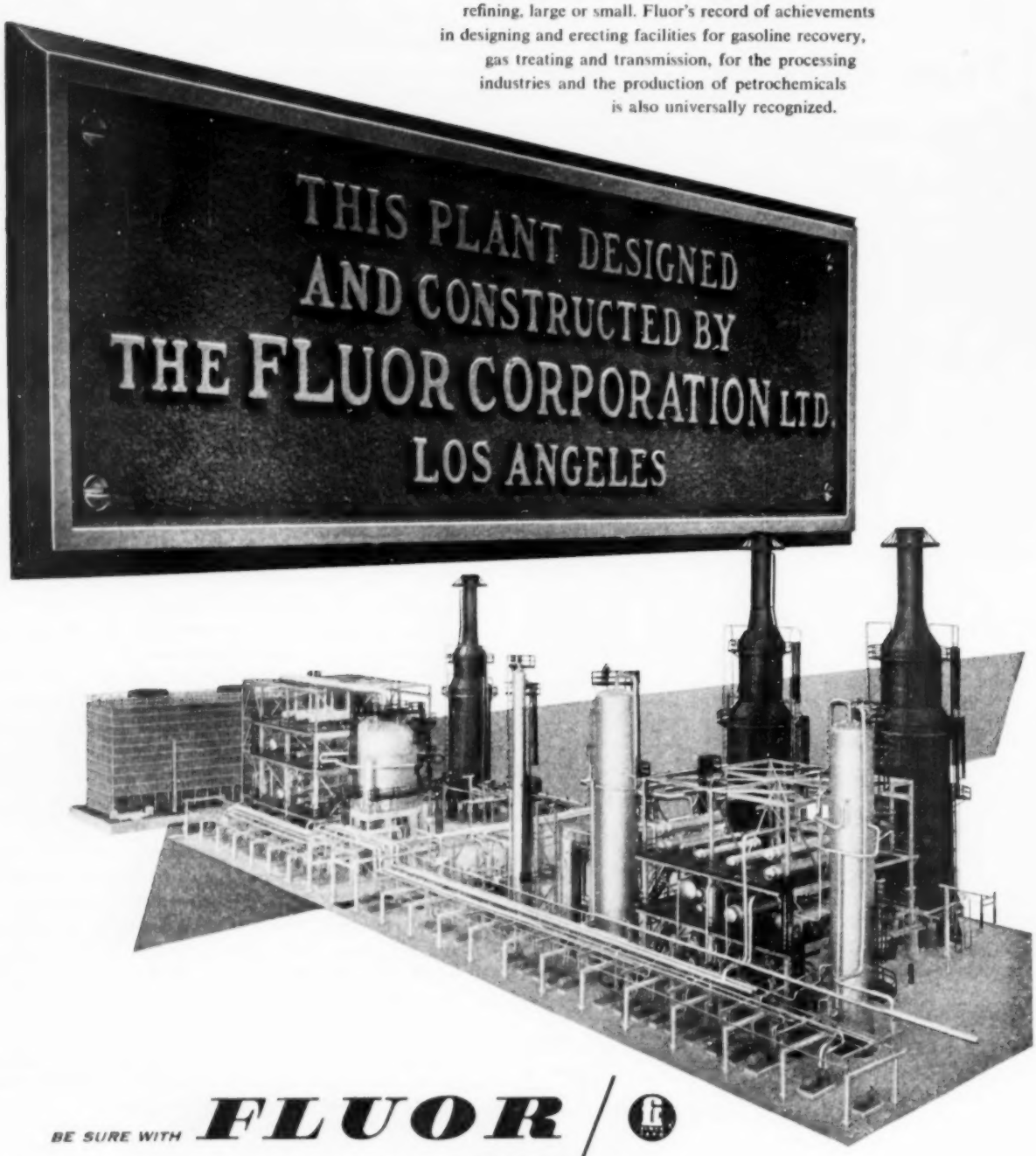
UNITED STATES STEEL

WILMINGTON, CALIFORNIA. The Crude Distillation and Vacuum Flashing Unit recently added during Union Oil's $26½ million refinery expansion program at Wilmington was designed, engineered and constructed by the Fluor Corporation, Ltd. Fluor also built many of the offsite facilities and interconnecting pipelines within the specified time and allocation. This is another example of Fluor's ability to handle any phase of petroleum refining, large or small. Fluor's record of achievements in designing and erecting facilities for gasoline recovery, gas treating and transmission, for the processing industries and the production of petrochemicals is also universally recognized.



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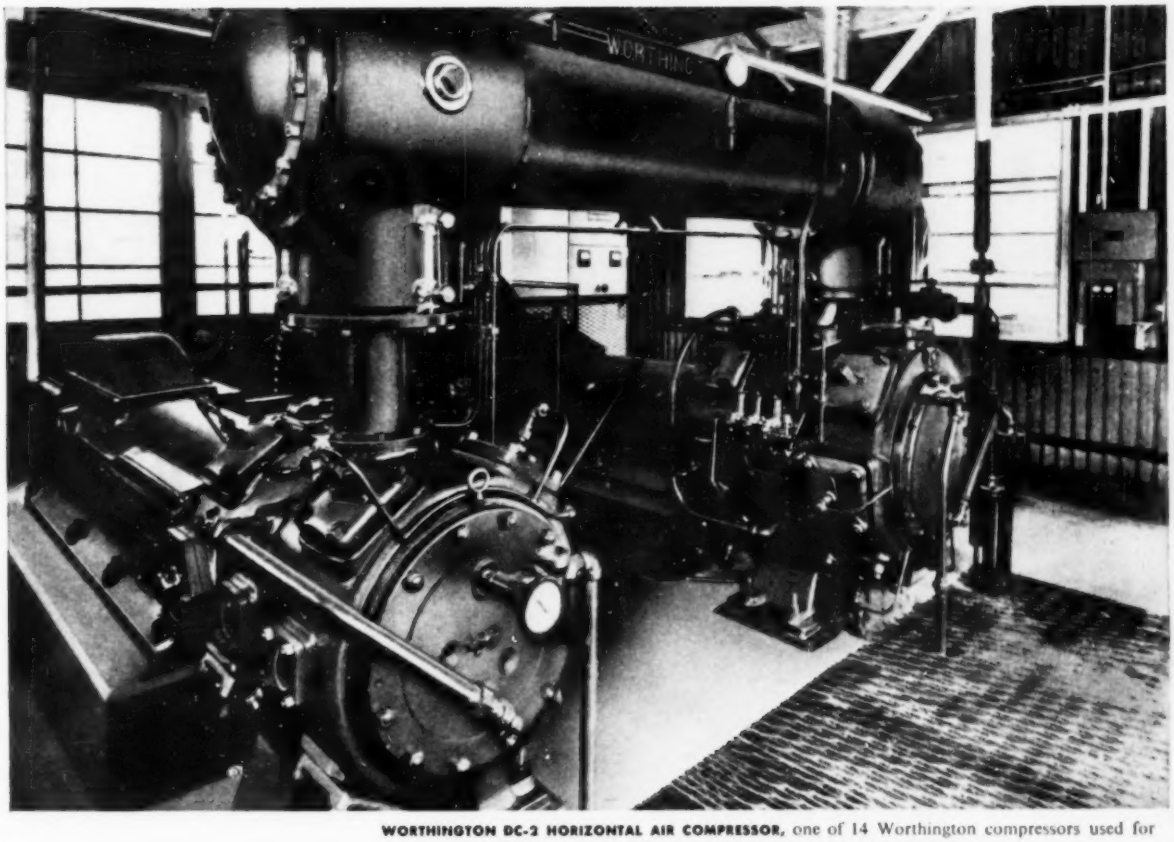
(*To obtain more data on advertised products see page* 280)



WORTHINGTON DC-2 HORIZONTAL AIR COMPRESSOR, one of 14 Worthington compressors used for various services at the Girard Point, Pa., station of the Gulf Oil Company.

THIS COMPRESSOR KEEPS PACE WITH VARIABLE LOADS

Like compressors in industry everywhere, this installation at a large eastern refinery must face many variable load problems. Unless properly handled, variable compressor loads often result in wasted power and high running costs.

Worthington Five-Step Variable Capacity Control solves this problem.

The by-pass regulation—as achieved by suction valve unloaders and clearance pocket unloaders—is exclusively Worthington and offers these important advantages:

Economy of power—the air required at any moment determines the power used.

Simplicity—inlet valves and unloading mechanism form one individual element, easily accessible.

Low operating temperatures—a cooler cylinder insures improved lubrication and low oil consumption.

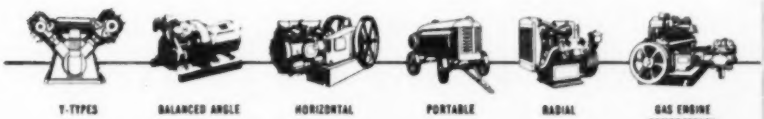
This Type DC-2 compressor is also equipped with the exclusive Worthington Feather* Valve—the lightest and most efficient compressor valve available.

Write for air compressor bulletin L-675-B1B to your nearest Worthington district office or to Worthington Corporation, Compressor Division, Buffalo, New York.

*Reg. U. S. Pat. Off.

A GLANCE AT THE INDICATOR PANEL of the Worthington five-step governor shows operating capacity at any moment.

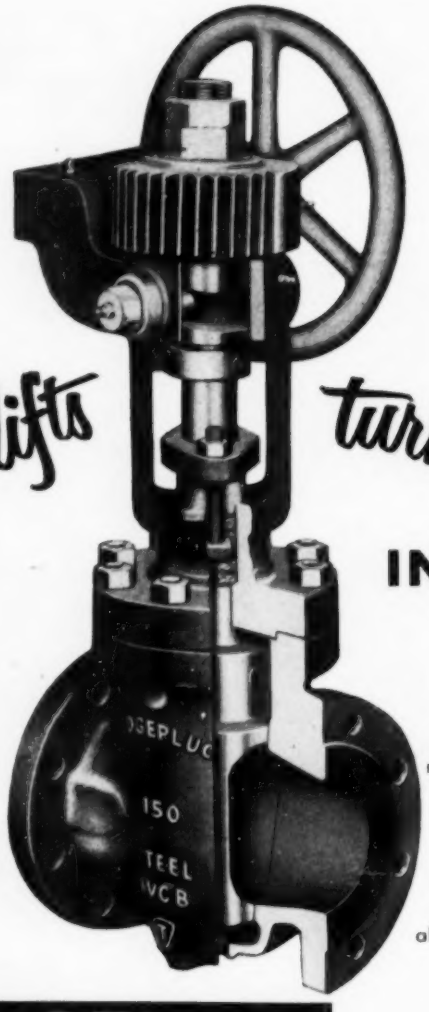
K 2.13



WORTHINGTON

Compressors

No Other Compressor Will Outperform a Worthington



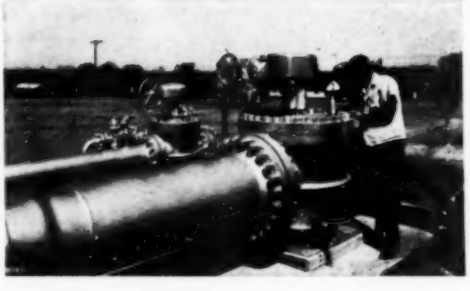
lifts *turns and reseats*

IN ONE OPERATION

The Wedgeplug Principle—which is the application of power through a simple, patented cam mechanism—assures a quick, positive lift of the tapered, *non-lubricated* Plug from its protected, raised seating surfaces; a 90-degree turn; and, then, a lowering and tight re-seating of the Plug—all accomplished in sequence, and by a few turns of the handwheel. Trouble-free action, regardless of temperature or pressure.

WEDGEPLUG
General Service
STEEL VALVES

Large port openings assure minimum pressure drop. Compact, easy to adjust while in service. Available in three types: Wrench-operated, Handwheel-operated, Worm-Gear-operated. All sizes can be steam-jacketed. Adaptable for remote control.



WRITE FOR CATALOG NO. 52-12-W

WEDGEPLUG VALVE COMPANY, INC.

1306 S. BROAD AVENUE, NEW ORLEANS 15, LA.

An Affiliate of* STOCKHAM VALVES & FITTINGS, *Birmingham, Ala.

Letters

More on Critical Alloys

. . . There is some evidence that the supply of these strategic elements is not as scarce as it previously was. ["How to Save Those Critical Alloys," Dec., 1952, p. 1776] . . . difficult to obtain any definite commitments from the lame duck bureaucrats in Washington since everything there has been predicated on January 20. As guide to thinking, however, the API and ASTM emergency alloys are to be confirmed at the February meeting of the ASTM. The reason for confirming these emergency alloys is that there has been no authority yet for their change and this authority must issue from Washington. The interim rules can be dropped at short notice and without any real harm being done, so my guess is that as the alloy materials become procurable there will be less attention paid to the rules which have been formulated until they finally cease to exist.

JOHN J. B. RUTHERFORD
Chief Metallurgist
The Babcock & Wilcox Co.
Tubular Products Division
Beaver Falls, Penna.

● Thank you, reader, and author, Rutherford. ("Heating Tube Failures —Cause and Prevention," Rutherford, PETROLEUM PROCESSING, Jan. 1953, pp. 62-69).

. . . on the question as whether requirements might be broadened: we feel that it is entirely possible that new refinery processes will be developed requiring additional critical alloys. Several of the processes now in common use that were developed within the past 10 or 15 years are making extensive use of alloy equipment to resist corrosion and high temperatures. Within the near foreseeable future, however, the requirements as set forth [in the Interim Report] are believed to be adequate.

C. E. RAWLINS
Manager, Test Division
Phillips Petroleum Co.
Engineering Dept.
Bartlesville, Okla.

●Whether those "critical" alloys remain critical or not—depending on the course of events in the next few months—the report prepared by the API Interim Advisory Committee on Alloy Steels, headed by Gulf Research & Development Co.'s Blaine B. Wescott, and including some 28 top authorities from both users and makers of steel, is highly recommended reading in our book at any time.

The eleven recommendations this group made to Petroleum Administration for Defense are just plain, down-to-earth, practical advice for the industry—*Editors.*

To meet price and performance specifications

ORONITE LUBE OIL ADDITIVES

are tailor-made to your base oils

Why not talk over your problem with us?

You will find Oronite Additives offer important savings in treating costs because of the high quality detergent and inhibitor chemicals from which they are made. Oronite's standards are rigidly high so you can be sure of uniformity in your finished oil.

An additive specialist will call on you on request. Phone or write the Oronite office nearest you.

ORONITE CHEMICAL COMPANY

THE NAME TO WATCH IN CHEMICALS

With Oronite Additives you can formulate oils to meet the new A. P. I. Service Classifications and can meet specifications for 2-104-B, MIL-O-2104, Supplement 1 and Series II oils.

ORONITE CHEMICAL COMPANY

200 SANSOME STREET, SAN FRANCISCO 4, CALIF.
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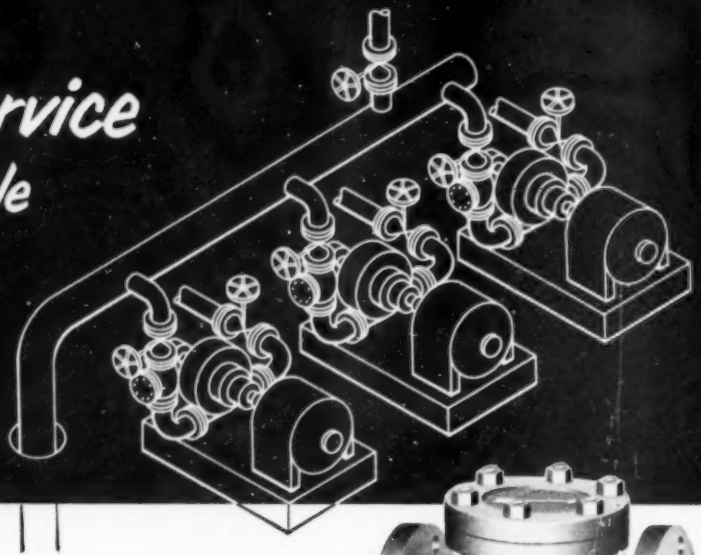
STANDARD OIL BLDG., LOS ANGELES 13, CALIF.
600 S. MICHIGAN AVENUE, CHICAGO 5, ILL.
MERCANTILE SECURITIES BLDG., DALLAS 1, TEXAS

(To obtain more data on advertised products see page 280)

It's not what you Pay for Valves ...it's what they Cost you

on Water Service for example

(A Case History)



What you pay for valves is not the final criterion of value. Not when maintenance costs can quickly equal or exceed purchase price. And a valve that threatens production is no bargain at any price . . . no attraction to a thrifty buyer.

Take this case in a large eastern paper mill. A single bank of water pumps supplied the entire mill. Leaky check valves at these pumps were a constant problem. Regularly, the checks needed replacement, only to be found leaking between pumping cycles a few months later.

A change-over to Crane Quality Check Valves put a complete stop to this costly maintenance and threat to production. Installed well over a year, Crane checks are protecting the mill against loss of water pressure at no added cost.

Today, more than ever, you need greater assurance of quality in piping materials. You get it in Crane Valves—the recognized standard of quality with thrifty buyers in every industry. Your big Crane Catalog offers complete selections for all needs; your Crane Representative is always at your service.

Crane Check Valves are made in all types, in brass, iron, steel, and alloys. See your Crane Catalog.

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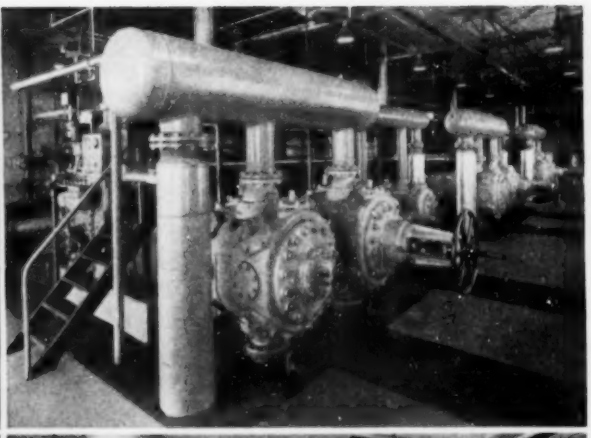
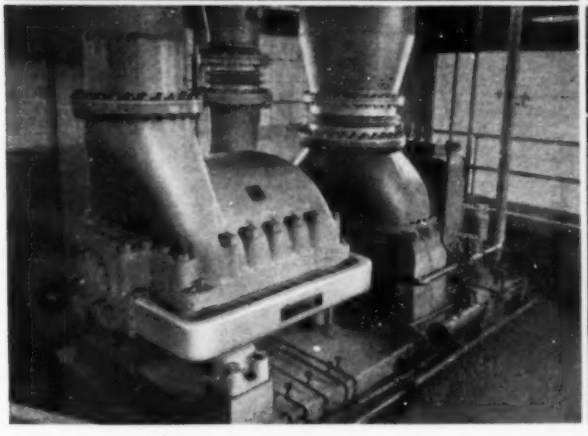
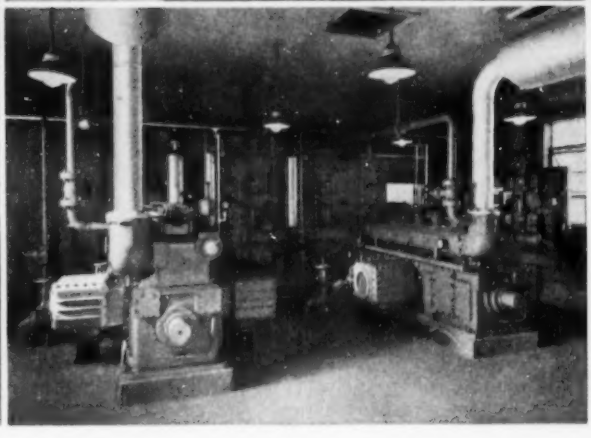
IN CANADA'S BOOMING OIL INDUSTRY







British American solves all compressor requirements with Clark "Centrifugals" and "Right Angles" in Saskatchewan's first cat cracker

With the recent completion of Saskatchewan's first catalytic cracking unit, Clark compressors again play an important role in Canadian refinery progress.

In this 9000 bbl. per day addition to the British American Oil Company's Moose Jaw Refinery, pressure-volume conditions dictated the use of both centrifugal and reciprocating compressors:

To meet the air requirements, a Clark No. 4 Multi-Stage Centrifugal Compressor (above left) was chosen. High capacity, low discharge pressures and the availability of process steam made this unit the most advantageous, economically and process-wise.

To handle vapor recovery requirements, 3 Clark 660 bhp "Right Angle" Compressors (upper right) were chosen. High discharge pressures, moderate capacity and the need for flexibility made them the most logical choice. (In addition, two Clark HMA-6 Gas Engines (lower right) are driving water pumps for the refinery's water system.)

The advantages gained through the use of both centrifugal and reciprocating compressors, in certain applications, can be substantial. That's one of the big reasons why the trend is to equip with Clark compressors exclusively. Clark builds *both*. Clark builds *all* types. You are *always* assured of completely unbiased recommendations.

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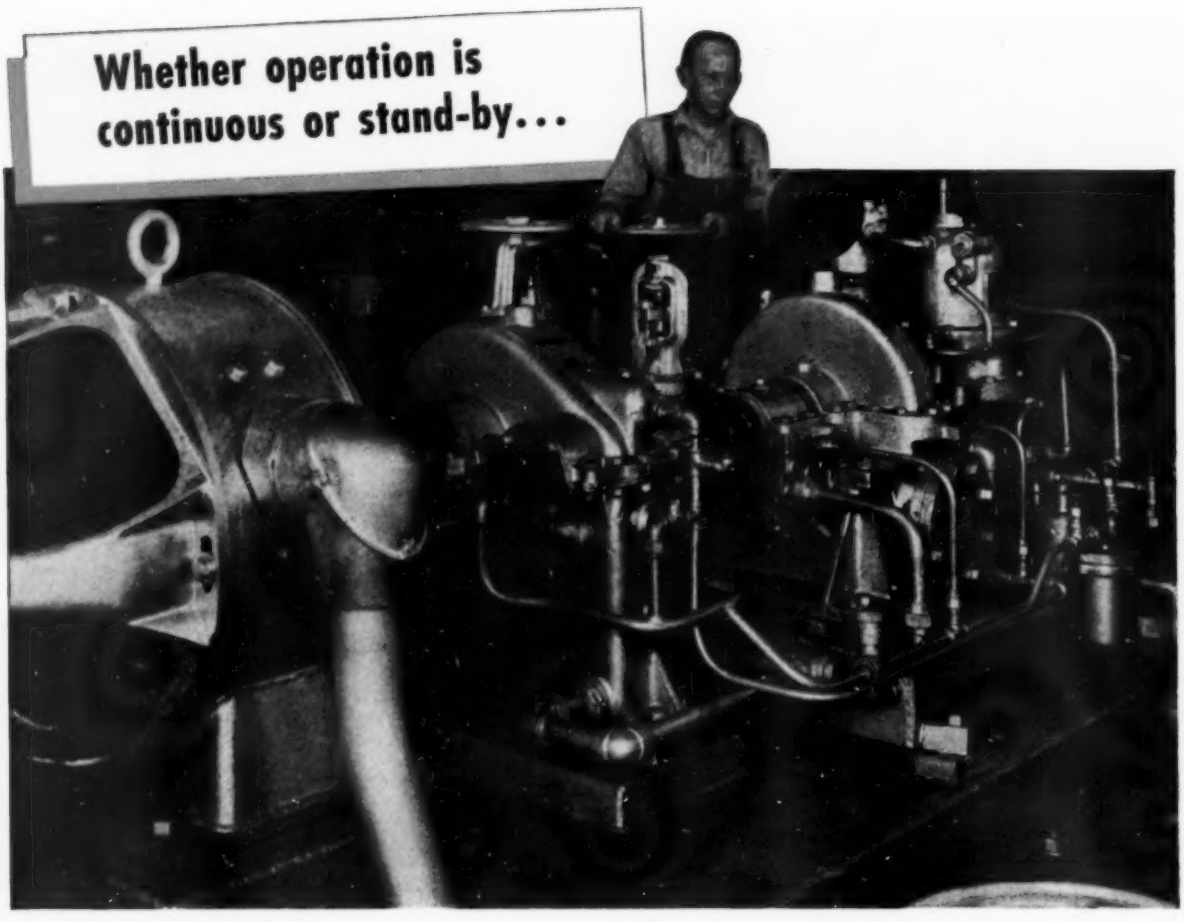

TYPE E turbines can handle it!

In the powerhouse of William F. Schrafft & Sons, makers of the famous "Schrafft's Chocolates," Charlestown, Massachusetts, the Type E turbine is used on a 40-kw, d-c exciter. The turbine exciter is supplementary to a motor-driven exciter for one 750- and two 1000-kw Westinghouse Turbine-Generators.

Of this installation, both the Chief Engineer and the Chief Power Plant Operating Engineer stated, "We are impressed by the design, appearance, and smooth-running qualities of the Type E turbine, and also the unique design of the oil-relay governor and forced-feed lubrication which the Type E provides." This all-Westinghouse end of Schrafft's power plant includes a new 1000-kw Westinghouse Geared Turbine-Generator, served by existing Westinghouse switchboard equipment and motor-generator sets.

Here's the general-purpose turbine that meets the many stern demands of modern industry. Regardless of operating conditions, the Type E is built to give dependable, trouble-free, economical performance for long periods of continuous operation . . . or instant operation when used as a stand-by drive.

Other types in the complete Westinghouse general-purpose turbine line include heavy-duty and multi-stage units for applications requiring higher temperatures and pressures, higher speeds, greater horsepower, extraction for process applications or higher efficiency than can be obtained with single-stage machines. Get the facts on this broad turbine line . . . call your nearby Westinghouse Office, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-50540

YOU CAN BE SURE...IF IT'S
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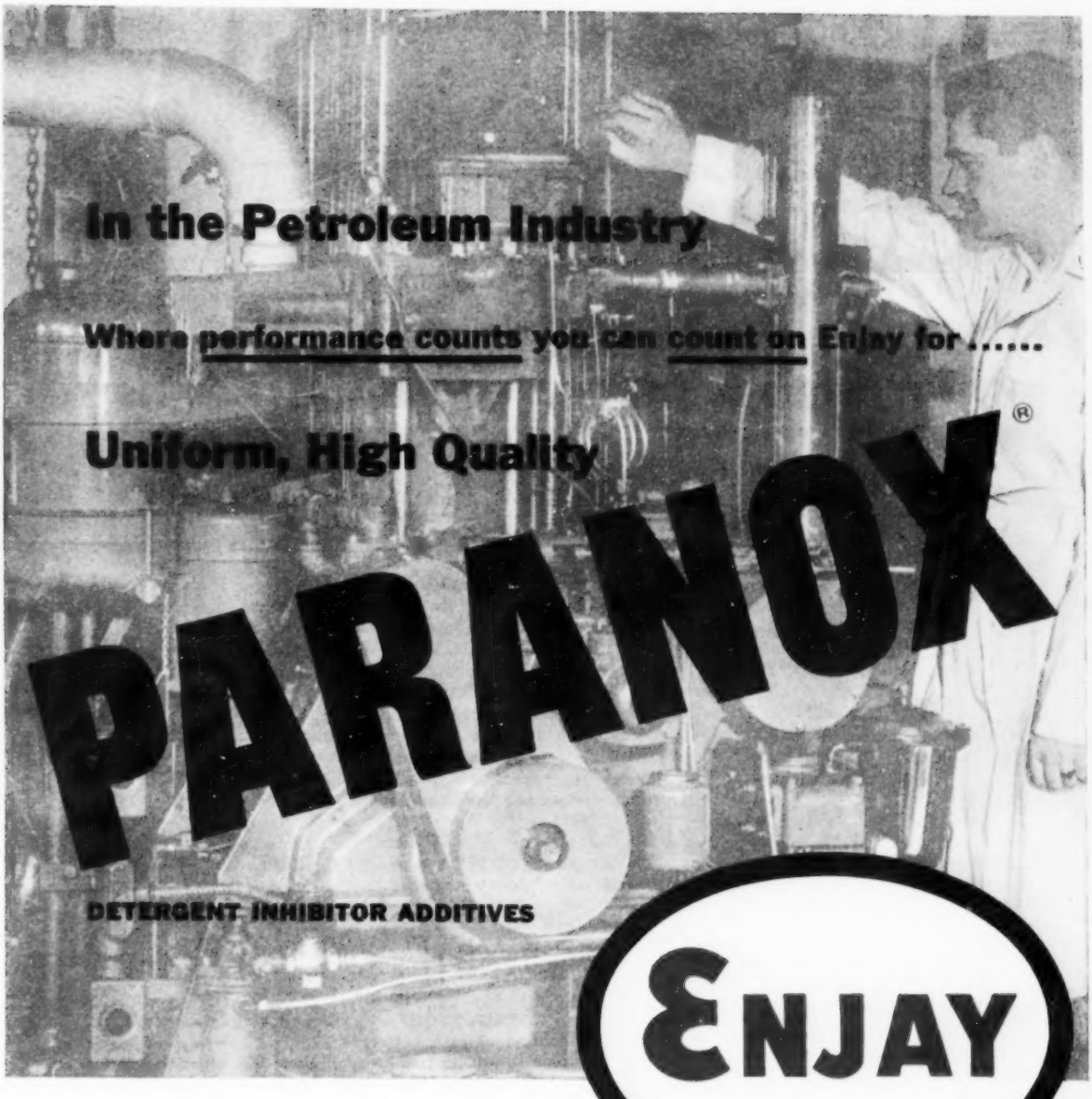
TYPE E Turbines



A pioneer and leading marketer of PARANOX additives, the Enjay Company with its affiliates has constantly expanded its production facilities to keep pace with the greatly increased demands of the petroleum industry. More and more refineries and marketers of leading motor oils are using Enjay detergent inhibitor additives to improve the quality of their products.

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Dicyclopentadiene
Naphthenic Acids
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Decyl Alcohol

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PETROHOL 95
PETROHOL 99
Iso-Octyl Alcohol
Decyl Alcohol
Tridecyl Alcohol
Dicyclopentadiene
Isoprene
Butadiene
Ethyl Ether
Isopropyl Ether
Tripropylene
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The Enjay Company has long been recognized as a leader in the development and marketing of high-quality products for the oil, surface coating and chemical industries. Backed by greatly expanded plant and distribution facilities, the Enjay Company is supplying a constantly growing list of chemical products to many different industries.

BE SURE TO CALL ON ENJAY FOR YOUR CHEMICAL NEEDS

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(To obtain more data on advertised products see page 280)

take a CLOSER LOOK at B&W ALLOY TUBING for high temperature applications

CARBON-MOLY • CROLOY ½ • CROLOY 1¼
CROLOY 2 • CROLOY 2¼ • CROLOY 3-M • CROLOY 5
CROLOY 5-SI • CROLOY 7 • CROLOY 9-M

All of these intermediate alloys, developed for oil refinery service, are being used extensively in a wide variety of high temperature applications. All have earned universal acceptance and praise for giving optimum service satisfaction with economy over the years. The accompanying table shows the extensive range of temperature, pressure, corrosion, and oxidation conditions met by B&W Alloy Tubing. Technical data on these analyses is contained in Bulletin TB-12, available upon request. Call on Mr. Tubes—your B&W Tube Representative—to get the benefit of the extensive tubing service he represents, on your specific petroleum processing applications.

CARBON-MOLY —0.50% Mo—For services to 1050F requiring higher creep strength than carbon steel with no increase in corrosion or oxidation resistance.

CROLOY ½—0.60% Cr, 0.50% Mo—For operating conditions to 1075F requiring properties superior to carbon-moly with respect to graphitization and creep strength.

CROLOY 1¼—1.25% Cr, 0.50% Mo, 0.75% Si—Economic grade good creep strength properties up to 1100F. Somewhat more corrosion resistant than chromium-free steels.

CROLOY 2—2% Cr, 0.50% Mo—Economic grade for resisting both oxidation and corrosion, with excellent high-temperature strength, up to 1150F.

CROLOY 2¼—2.25% Cr, 1.00% Mo—Exceptionally high creep strength up to 1175F for polymerization and high pressure cracking. Otherwise similar in properties and characteristics to Croloy 2.

CROLOY 3-M—3% Cr, 0.90% Mo—Somewhat better creep properties, and resistance to corrosion and oxidation up to 1175F than Croloy 2.

CROLOY 5—5% Cr, 0.50% Mo—For operating conditions up to 1200F where corrosion resistance is a primary requirement—with creep strength and oxidation resistance superior to Croloy 2.

CROLOY 5-Si—5% Cr, 0.50% Mo, 1.50% Si—For operating conditions up to 1300F where oxidation resistance is a primary requirement. Excellent resistance to scaling under straight oxidizing conditions.

CROLOY 7—7% Cr, 0.50% Mo, 0.50-1.00% Si—For operating conditions up to 1250F where corrosion resistance is the primary requirement. Somewhat more oxidation resistant than Croloy 5.

CROLOY 9-M—9% Cr, 1% Mo—For severe operating conditions up to 1300F where high corrosion and oxidation resistance are essential as in hydrogenation processes.

Steels from CROLOY 1¼ upward are electric furnace alloy steels which are normally cleaner and of better quality than open hearth steels. This contributes to greater reliability and improved creep properties at elevated temperatures.

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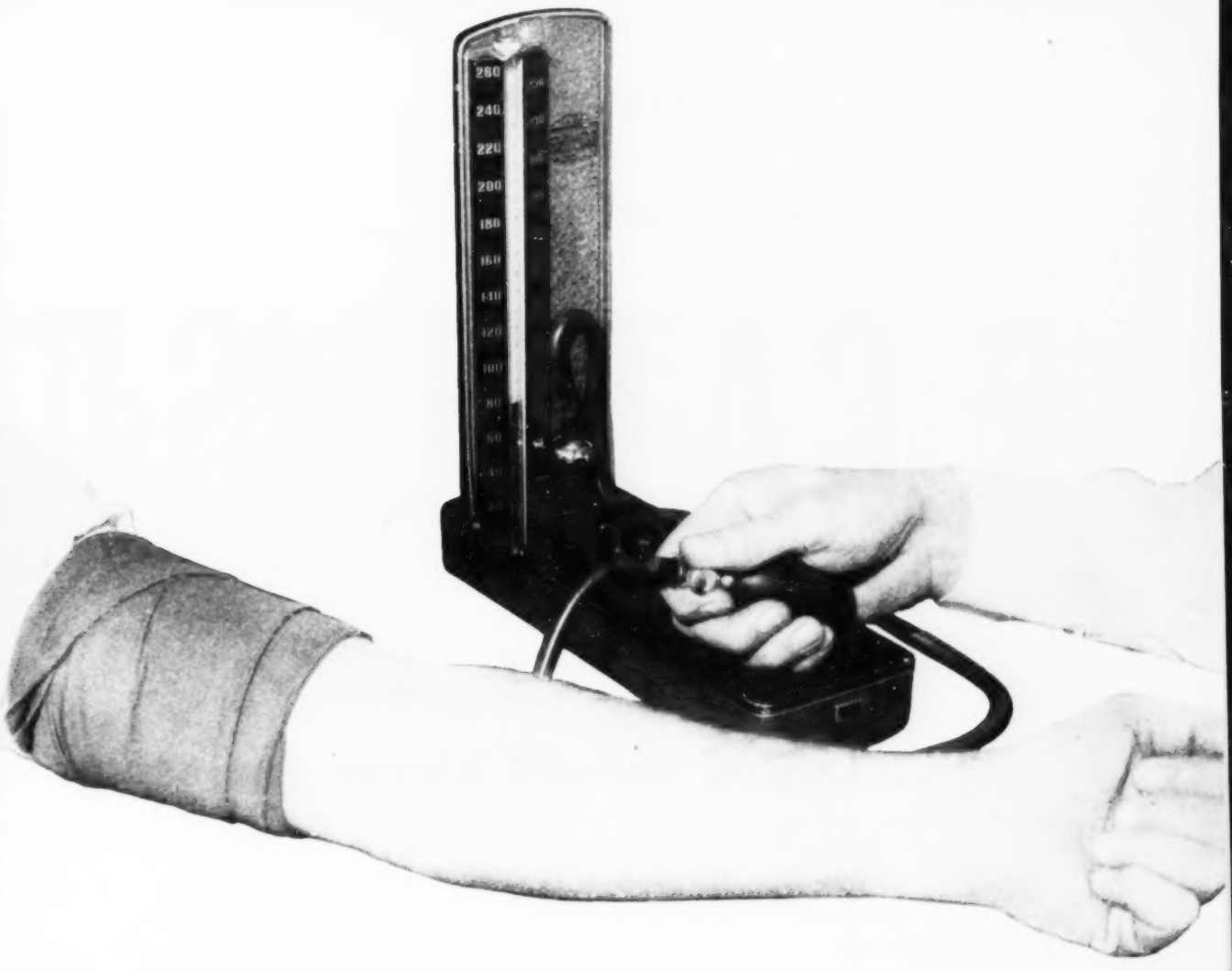

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It's the CATALYST

That's why you should know the story behind the catalyst used in

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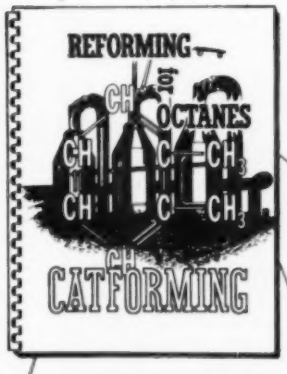
CATFORMING is now in successful commercial operation, furnishing positive proof that IT'S THE CATALYST THAT COUNTS. You are invited to share the many benefits of CATFORMING by joining our ever-growing list of licensees. Call or write for our new detailed bulletin for your introduction to CATFORMING. The Atlantic Refining Company, Research and Development Department, P. O. Box 8138, Philadelphia 1, Pa. (Telephone, Howard 5-2345.)



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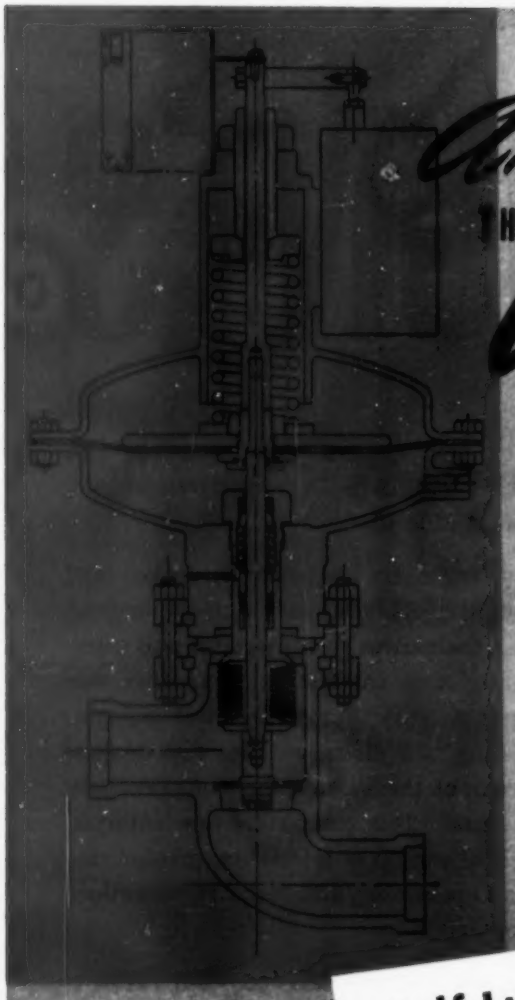

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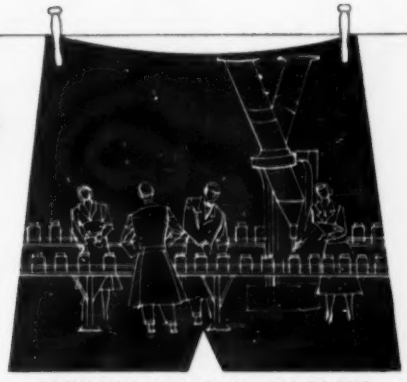

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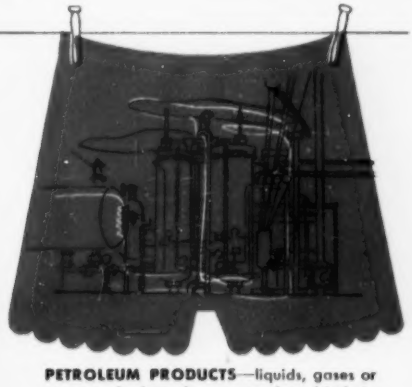

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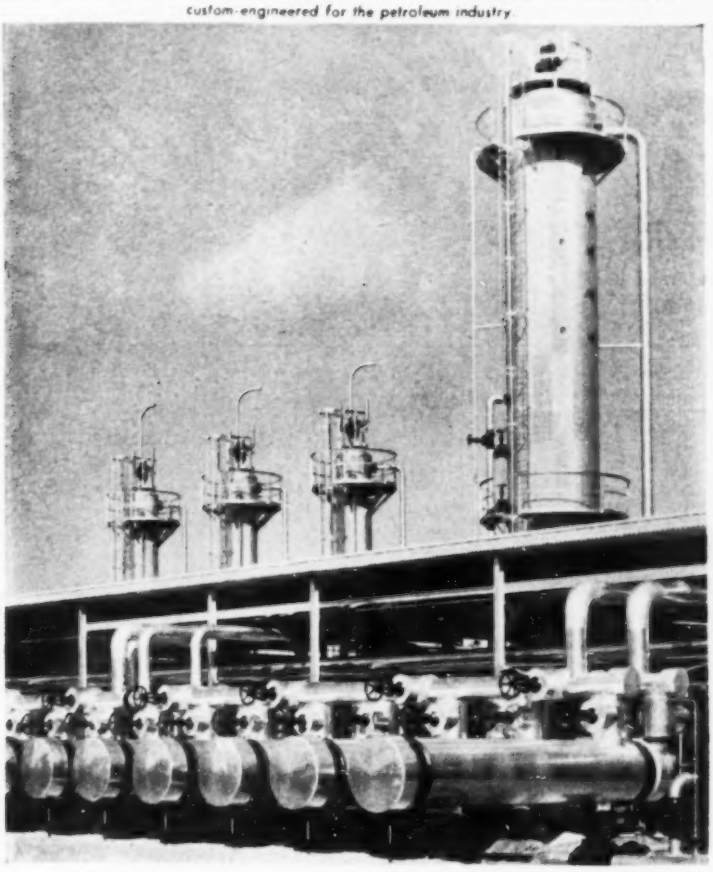

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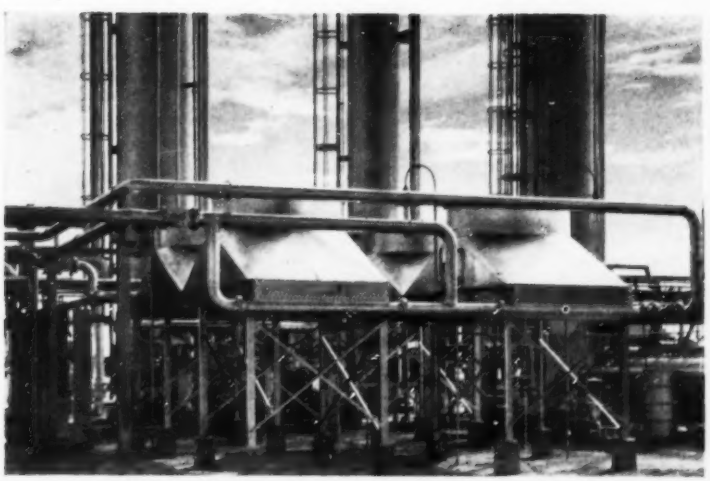

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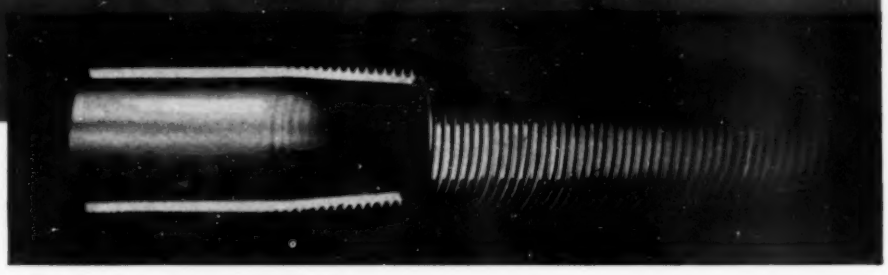

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Illustrated above is a cut-away section of the unique Wolverine Trufin* showing the integral fin construction.

Note that the fins are formed from the wall of the tube. They are one and the same metal. Because of this all-one-piece construction, the fins will withstand vibration and sudden temperature changes.

The increased surface area provided by the smooth, clean surface of the fins allows liquids and gases to flow freely permitting the maximum in heat transfer efficiency.

Trufin is available in a wide range of sizes and alloys to meet your particular corrosion problems.

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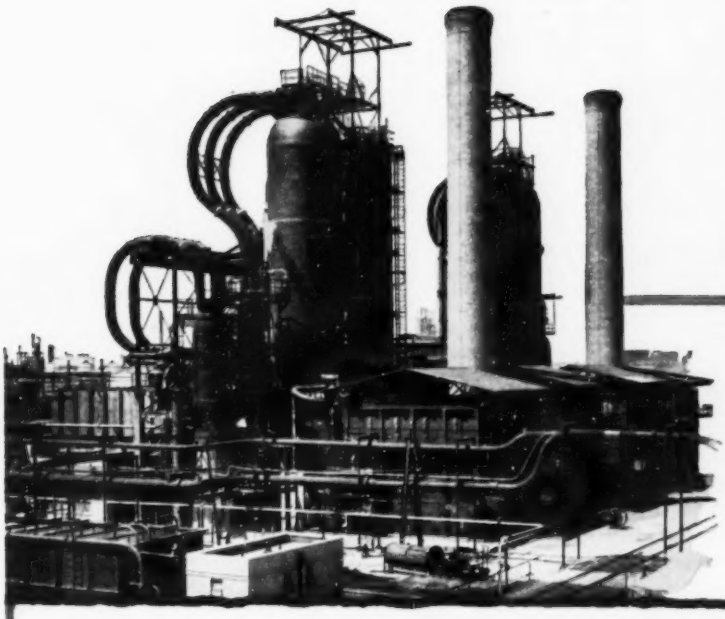


Carey INSULATION is at work for GULF . . .

keeping process and steam lines operating at lowest cost

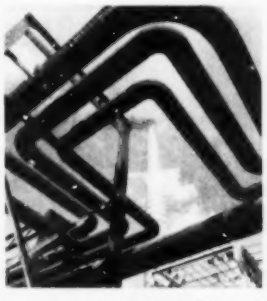
Refinery men demand *quality* insulation for processing operations. It's needed to keep fluids at constant temperatures. Helps cut fuel waste.

Since 1929, Carey insulation nas been in continuous service at the Port Arthur, Texas plant of the Gulf Oil Corporation. Over the years, it has proven itself equal to the punishing strains of vibration and rapid expansion and contraction of equipment encountered in refinery operations . . . while guarding against heat loss, holding the line on costs!

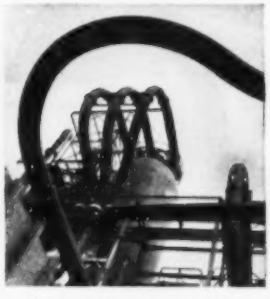
In *your* plant, you'll find dozens of applications where a Carey insulation material can conserve heat, save fuel. Carey's complete line of high and low temperature insulations includes blocks, blankets, pipe wrapping and jackets, cements and new Super-Light 85% magnesia in precision-sized blocks and nesting "O.D." pipe coverings that are easy and economical to apply.

Whether your problem is one of insulating "straight runs" or complicated shapes, a Carey Industrial Sales Engineer can show you why Carey insulation is best for the job. He'll gladly furnish you with complete technical and application data. No obligation to you. Telephone, wire or write our nearest office today.

Another Carey product—Careystone Corrugated Asbestos-Cement Roofing and Siding—protects Gulf Oil Corporation's warehouse at Port Arthur, Texas. This material is absolutely impervious to corrosion, rust, rot, decay; never requires painting or preservative treatment; virtually maintenance-free!



"Worm's eye" view of live and exhaust steam lines insulated with Carey materials. Besides the usual hazards of expansion, contraction and vibration, this Carey installation stands up under the extremely hot, humid weather of the Gulf area.



Carey insulation materials have weathered 23 years of continuous service on the fractionating tower and vapor lines of these atmospheric and vacuum stills at Gulf Oil Corporation's Port Arthur, Texas plant.

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of "Industrial Insulation." Tells all about Carey insulations, and how to select and use them. A copy is yours for the asking.

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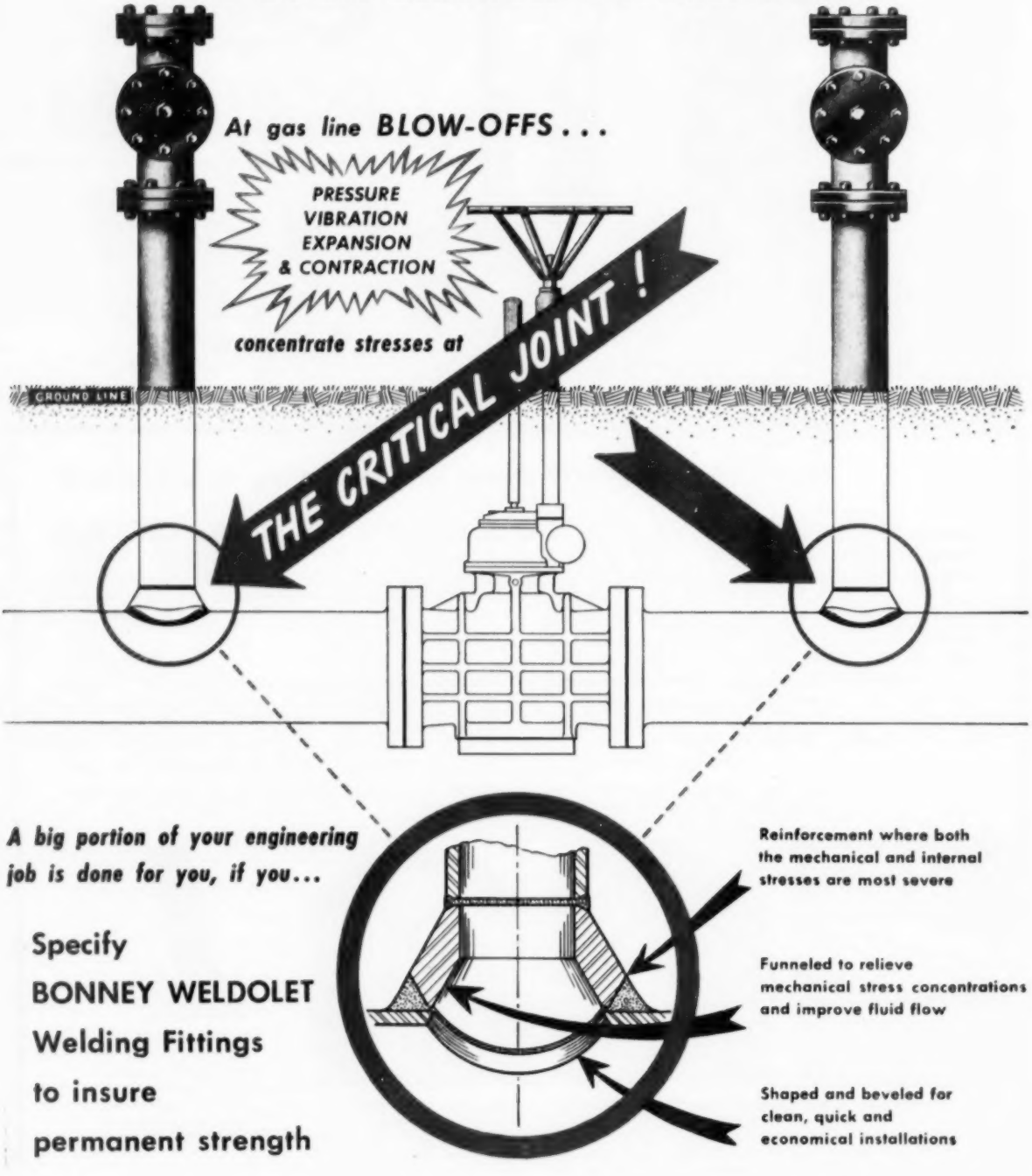
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PETROLEUM CHEMICALS DIVISION
NEWS

February ★ One of a Series of Interest to the Petroleum Industry ★ 1953

TECHNICAL MANAGER OF PETROLEUM CHEMICALS DIVISION

JOHN R. SABINA joined the Du Pont Company in 1937 after many years of development work in motor fuels and lubricants. He is a graduate of the University of Pennsylvania with a B.S. degree in electrical engineering.

After two years as an electrical engineer for the Baldwin Locomotive Works in Philadelphia, Sabina joined the Atlantic Refining Company in 1925 as a test engineer. There he developed the first audio-electrical device for measuring detonation in internal combustion engines. In 1936 he was named manager of Atlantic's Automotive Laboratory.

Sabina came to Du Pont initially to head a new group formed in the Organic Chemicals Department to develop chemicals for the petroleum industry. One of his first projects at Du Pont was designing the Petroleum Chemicals Laboratory at Deepwater Point, N. J. He became manager of this laboratory in 1938.

In 1944 he was transferred to Wilmington as manager of the Petroleum Chemicals Section of the Alcohol Division, in charge of both sales and development. When the present Petroleum Chemicals Division was formed in 1946 to manufacture and market all Du Pont petroleum additives including tetraethyl lead, Sabina was named technical manager of the new division.

JOHN R. SABINA

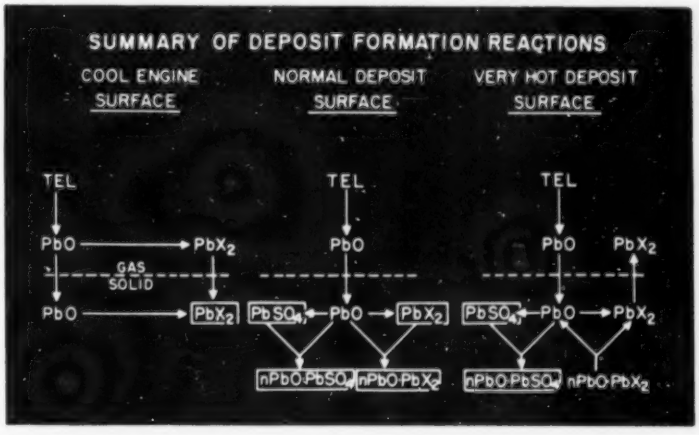
During World War II, he served as chairman of a Coordinating Research Council group formed to advise the armed services on gasoline storage stability problems. He has written numerous technical articles and papers for scientific publications and been especially active in the American Society for Testing Materials, the Society of Automotive Engineers and the Coordinating Research Council and the A.P.I. In 1944 he was elected vice president in charge of fuels and lubricants for the S.A.E.

Investigating the "How" and "Why" of Engine Deposit Formation

Studies at the Du Pont Petroleum Laboratory reveal the sequence of chemical reactions which occur in engine deposit formation.

The deposits which form on combustion chamber walls increase the tendency of fuels to knock.

This fact has long been known to petroleum and automotive engineers. But very little was known about the reaction mechanisms which result in the accumulation of these deposits—especially with fuels containing tetraethyl lead. And nearly all modern automotive fuels contain this compound.



THIS CHART SHOWS the compounds found in the deposit and the reactions by which they are produced under each of the temperature conditions studied.

Since Du Pont is a large supplier of tetraethyl lead, the Du Pont Petroleum Laboratory undertook a study of the reactions leading to the formation of the lead salt portion of combustion chamber deposits.

SMALL AMOUNT REMAINS

Although almost all tetraethyl lead decomposition products are removed from the combustion chamber with the exhaust gases, a small amount remains on the chamber walls in the form of inorganic lead salts.

Many of these salts are formed as a result of chemical reactions which occur in the combustion chamber after the fuel-air charge is burned.

In the studies, it was first determined that the reactions *might* influence deposit formation during any of the following stages:

1. Combustion.
2. Vapor state reactions following combustion.
3. Condensation of lead compounds

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OVER

PETROLEUM CHEMICALS DIVISION
NEWS

CONTINUED *Deposit Studies*

on cylinder wall.

4. Gas-solid reactions between lead salts and chamber gases.
5. Solid state reactions between lead salts in deposit.
6. Vaporization of lead salts.

The question then was, *how* do these reactions influence deposit formation?

TEMPERATURE INFLUENCE

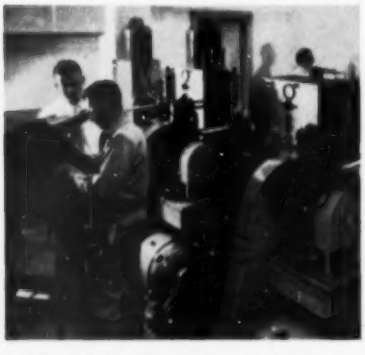
After studying each of these stages in the reaction sequence shown, the Petroleum Laboratory arrived at the following conclusions:

The course of the reaction is dependent on the temperature of the combustion chamber walls.

When the walls are clean and relatively cool (ca. 200°C.), the reactions result in lead halide deposit formation. But after deposit growth has produced an insulating area, the surfaces are hotter and a variety of higher melting compounds are formed. When areas of the combustion chamber, such as the exhaust valve, become very hot, the deposit composition changes so that only very high melting compounds are formed.

GASEOUS LEAD OXIDE

Gaseous lead oxide, produced from the decomposition of tetraethyl lead, does not undergo vapor state reactions except when the gas layer near a clean combustion chamber surface is cool. Under these special and transitory conditions, it may be converted by hydrogen halides into gaseous lead halides.



Section of a single-cylinder engine room in the Du Pont Petroleum Laboratory.

(Continued in next column)

SOLID LEAD OXIDE

Solid lead oxide has a short life as a deposit constituent. It is attacked by acid gases to form simple lead salts or reacts with the simple lead salts in solid state reactions to form complex lead oxysalts.

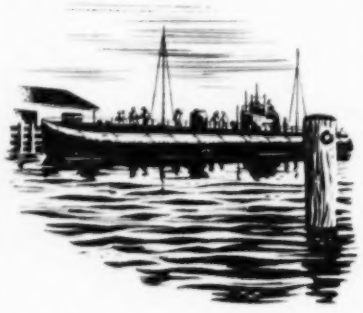
ONE OF A CONTINUING SERIES

This Du Pont study was one of a continuing series of systematic investigations on the mechanisms causing combustion chamber deposits. It is expected that it will be of considerable value to petroleum engineers who are now charting the course of developments aimed at preventing, or at least reducing, deposit formation.

The results of these studies will be made available by the American Chemical Society and the Du Pont Petroleum Chemicals Division.

NEW BOOKLET ON GASOLINE DYES

One summer day at the beginning of World War I, the German submarine *Deutschland* docked in Baltimore after a long voyage from Bremen.

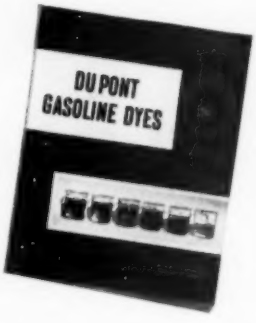


Her cargo, strangely, was not torpedoes—but 500 tons of dyes. These scarce chemicals were eagerly snapped up by American manufacturers.

This incident points up the great dependence of our country on the German Chemical Industry before World War I. Then Du Pont embarked on the long, often discouraging task of developing a process for making dyes equal to or better than those previously made in Germany. It took 18 years and millions of dollars to make the operation successful. But the final result was an American dye industry equalled nowhere else in the world.

The efficient use of gasoline dyes presents a number of handling and addition problems. To help you solve these problems quickly and easily, Du Pont recently brought out a new manual on gasoline dyeing. All the latest methods of addition, including dry dye eductor systems, are fully discussed.

It also contains data on meeting color requirements for military, aviation and leaded motor fuels. And full information—with solubility charts and spectrophotometer curves—on the complete line of Du Pont gasoline dyes is included.



For your copy, ask your Du Pont Petroleum Chemicals representative or district office for the booklet, "Du Pont Gasoline Dyes."

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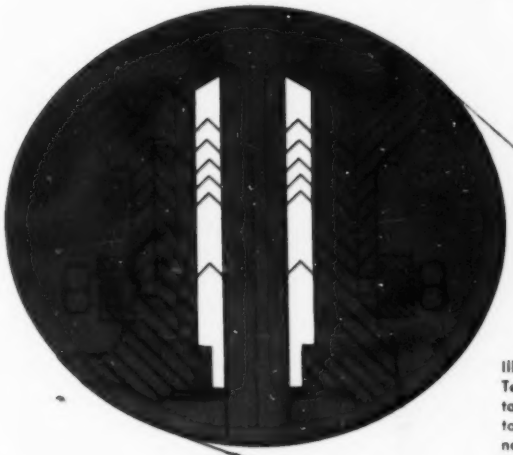
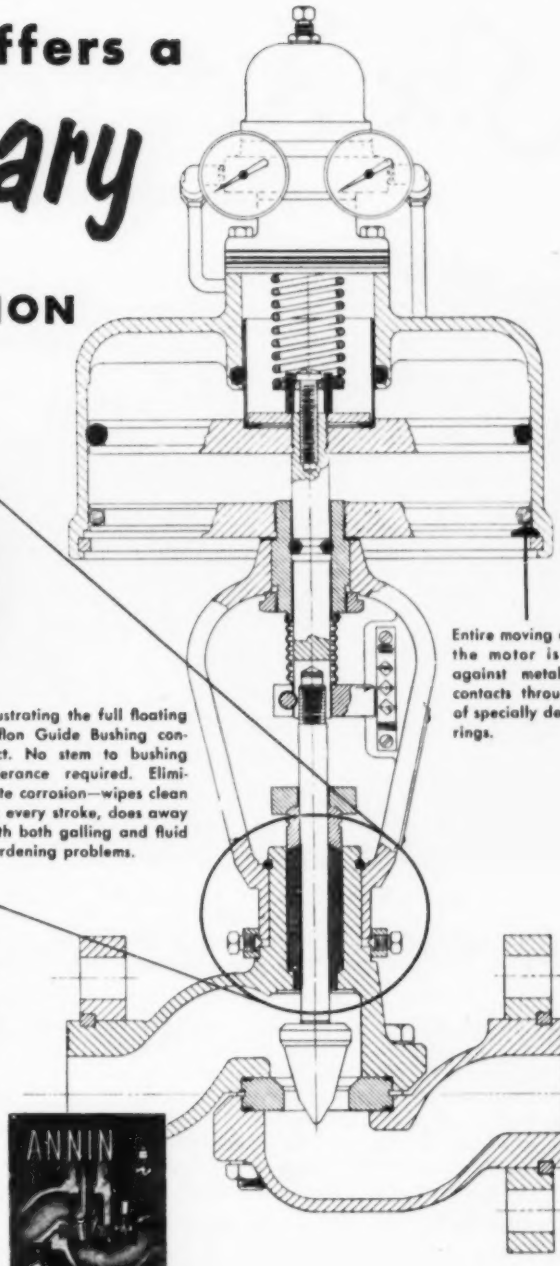


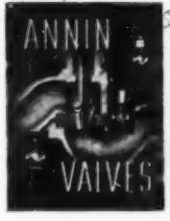
Illustrating the full floating Teflon Guide Bushing contact. No stem to bushing tolerance required. Eliminate corrosion—wipes clean on every stroke, does away with both galling and fluid hardening problems.



Entire moving assembly of the motor is insulated against metal to metal contacts through the use of specially designed "O" rings.

By incorporating a Teflon Guide Bushing,—Annin design provides mechanical perfection in control valve operation. How? Because now Annin valve offers full floating operation free from any metal to metal contact in moving parts. The valve stem floats in contact with Teflon,—the Domotor portion of the valve floats on Hycar "O" rings. Teflon eliminates valve stem galling, and all difficulties which develop when soft, corrosion resisting alloys are in contact as bearings.

Teflon is self-lubricating and requires no external lubrication. It won't stick so the customary tolerance between guide bushing and valve stem is eliminated. With the new type guide bushing used by Annin, an interference fit is provided and solidly retains the valve stem and plug assembly. The stem is wiped clean on every stroke preventing scale or dirt from scoring or any tendency toward fluid hardening problems. Valves now in service may be changed over to the new guide material.



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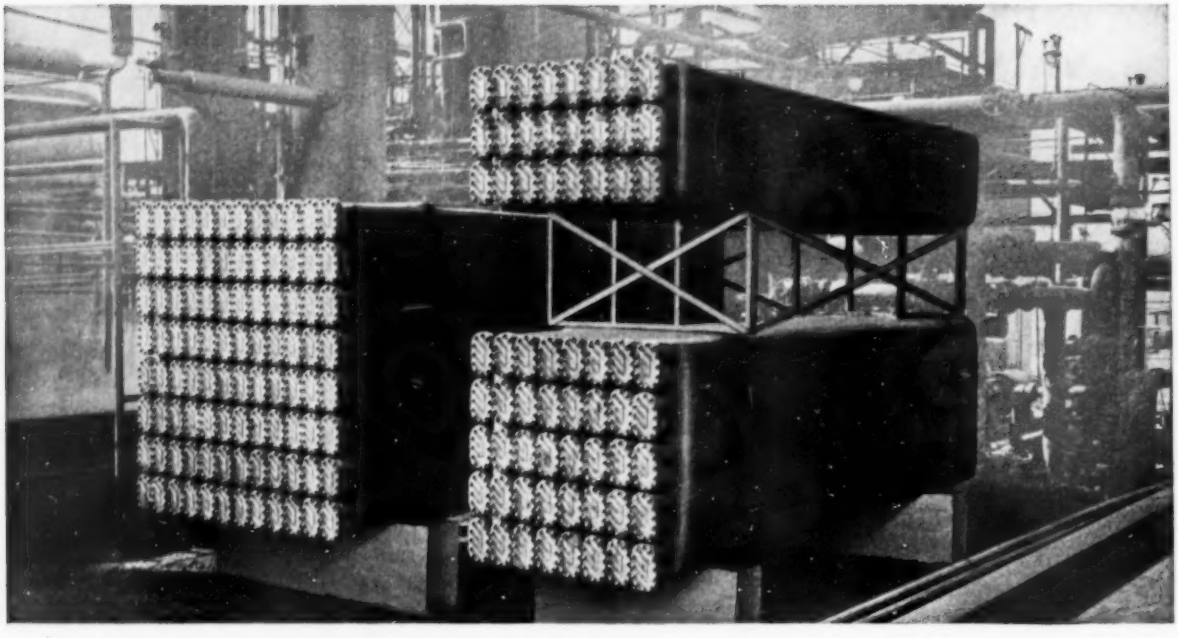

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FLEXIBILITY: If plant requirements change — and this is not uncommon — a "bank" of Brown Fintube heat exchanger sections can be disconnected and reassembled in different series-parallel arrangement easily and on short notice. "Bundle type" exchangers are not flexible. For them a change in duty usually involves designing — and waiting — for a whole new unit.

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REDUCED FOULING: Brown Fintube sections transfer more heat per lineal foot at lower surface temperatures. This minimizes coking. Also the longitudinal passages control the material flow eliminating eddies and reducing fouling.

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REDUCED STORES: Avoids tying up thousands of dollars in spare parts, housing and handling them.

PROMPT DELIVERY: Standardization permits economical assembly line manufacture from standardized parts — and prompt delivery.

If you heat — or cool — liquids or gases in your plant, you'll get a lot of ideas from our Bulletin No. 512. Send for a copy!

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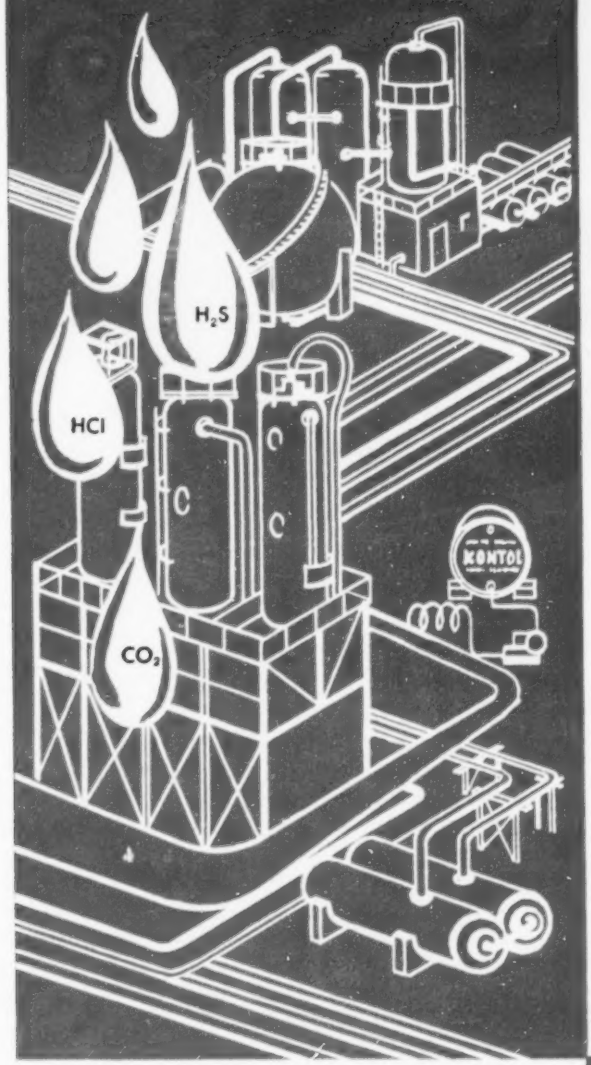
STOP

CORROSION LOSSES



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KONTOL can be used to control the corrosion of flow lines, fractionating towers, debutanizers, depropanizers, and stripping columns. It is also effective in the protection of heat exchangers, gathering systems, separators, scrubbers and overhead products lines.

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KONTOL provides protection against corrosion by adsorbing at metal surfaces as a thin, tough, impervious film which prevents contact by corrosive agents. It provides substantial protection against many kinds of refinery corrosion which, heretofore, have been accepted as being unavoidable.

For a prompt survey of your corrosion problems by a Tretolite Company refinery engineer, write or call the

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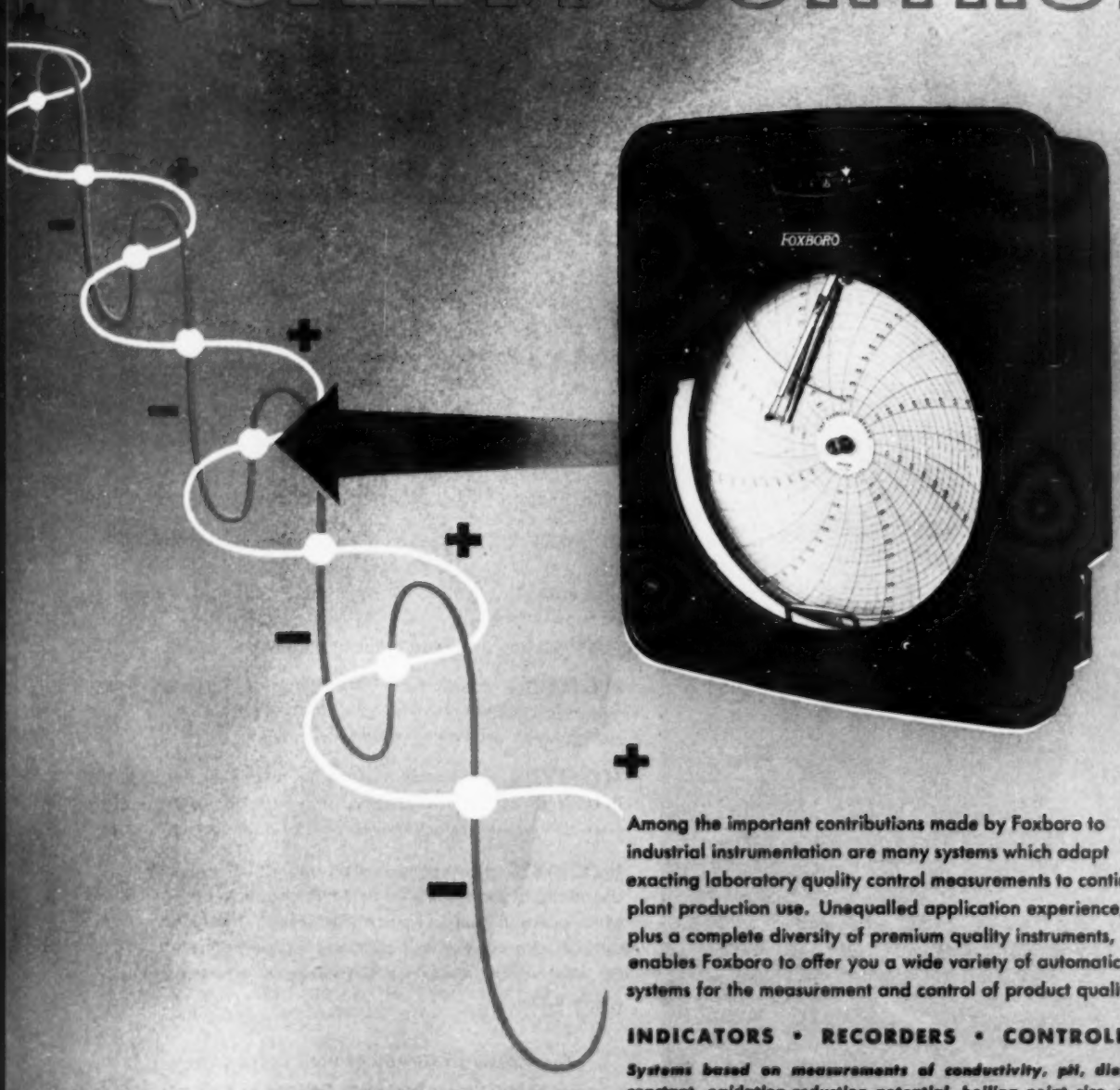

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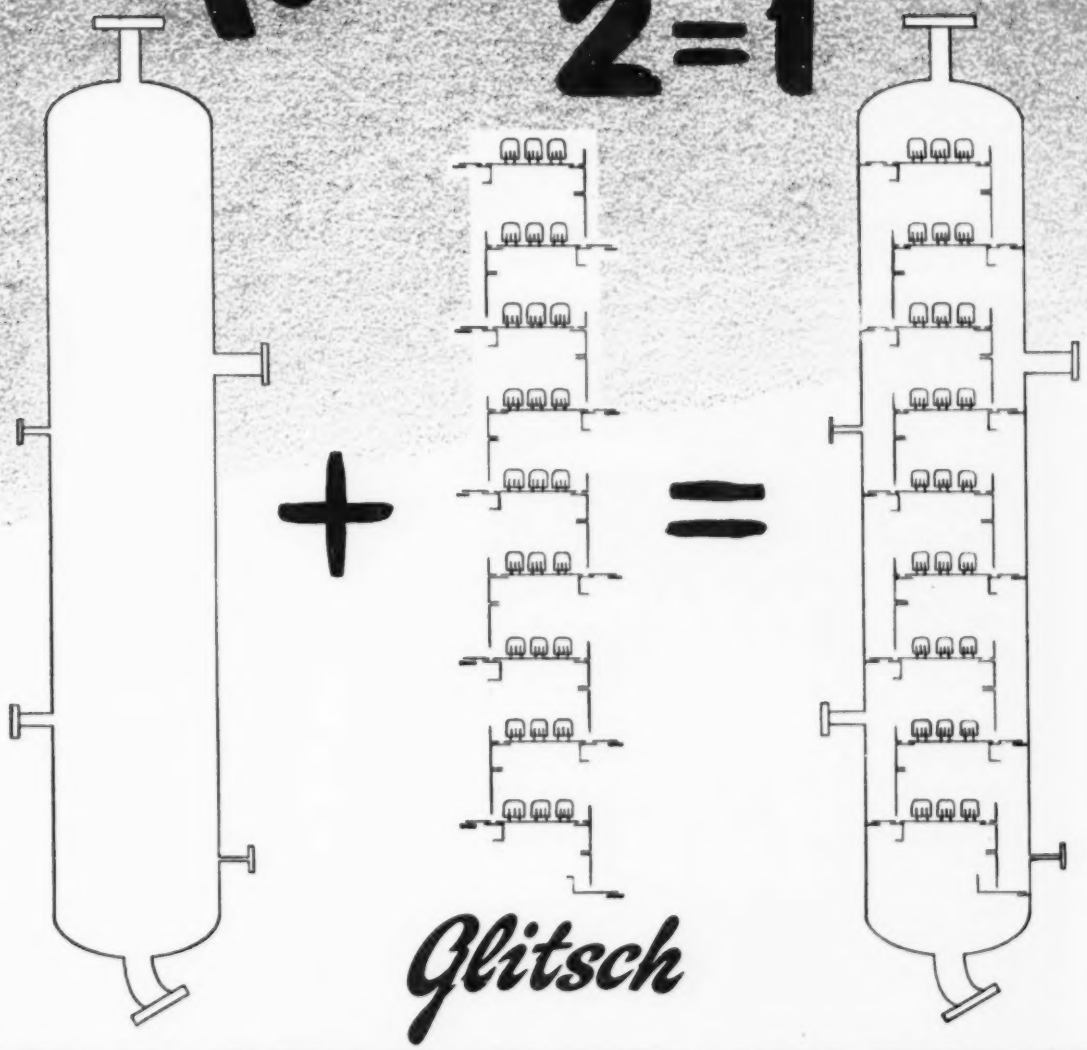

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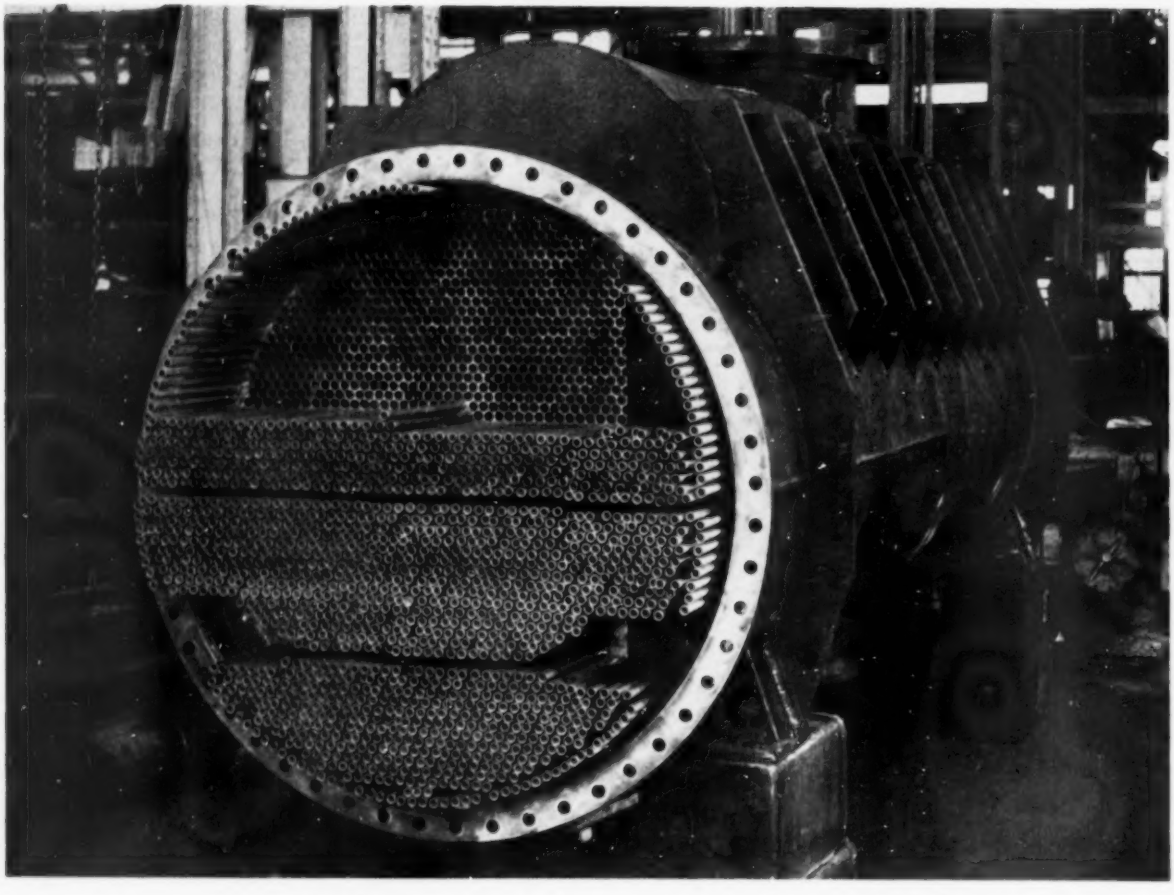

When this partially assembled heat exchanger was completed, it was installed as the surface condenser for a new vacuum still recently completed at Gulf Oil Corporation's Port Arthur, Texas refinery. The condenser was built by the Kewanee-Ross Corp., for M. W. Kellogg Co., the designing engineers and contractors.

Kellogg engineers approved ANACONDA Arsenical Admiralty Tubes for this particular equipment for one of the country's largest and most modern refineries. Tube dimensions are ¾ in. O.D. x .065 in. x 16 ft. long. The tube sheets are ANACONDA Naval Brass 56¾ in. diam. x 2 in. thick.

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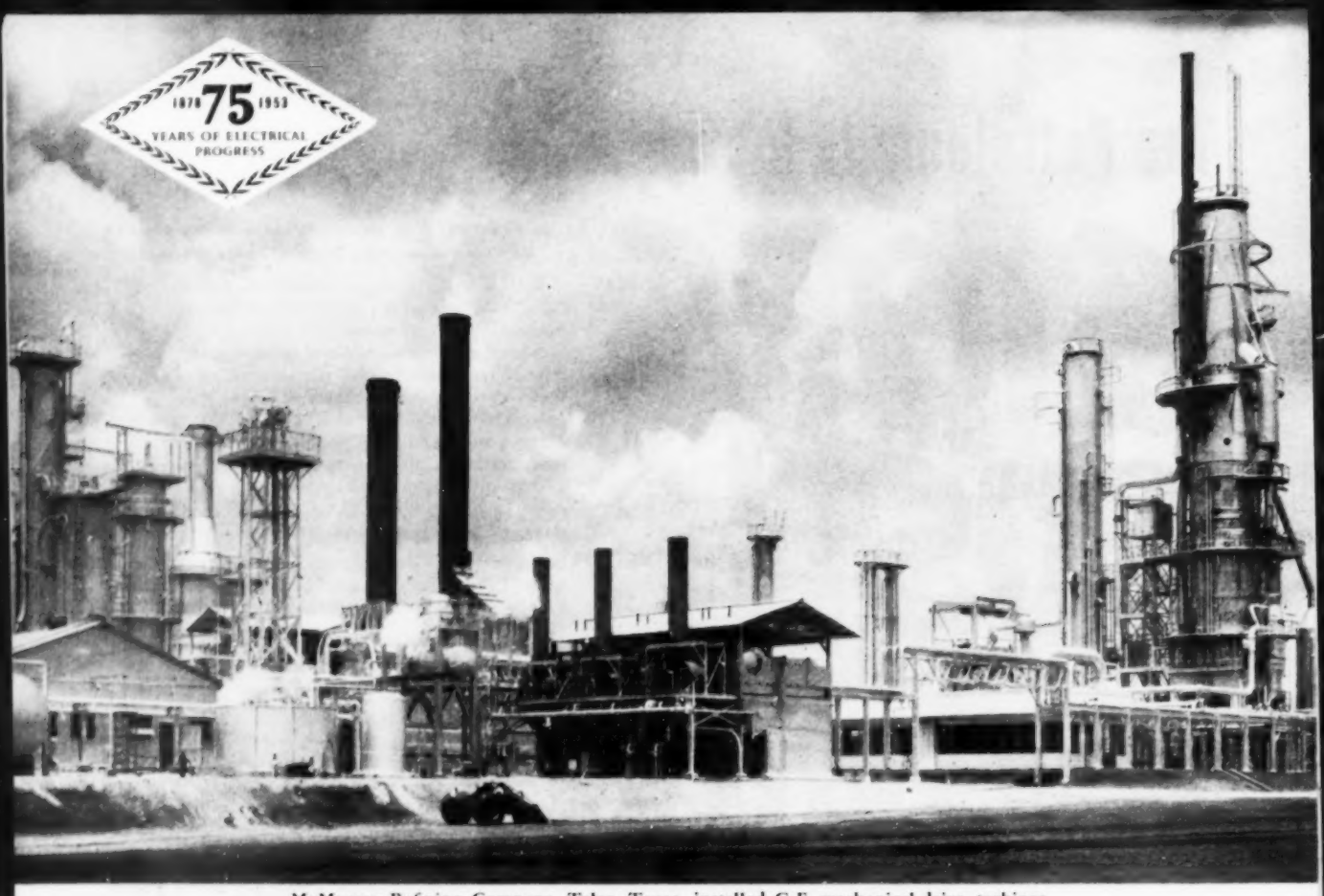
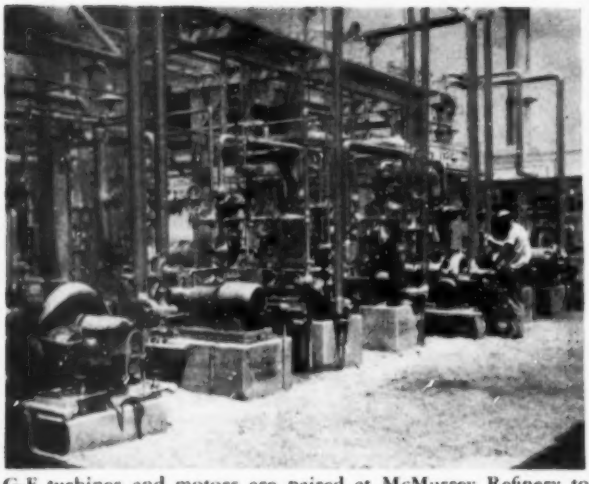
YEARS OF ELECTRICAL PROGRESS

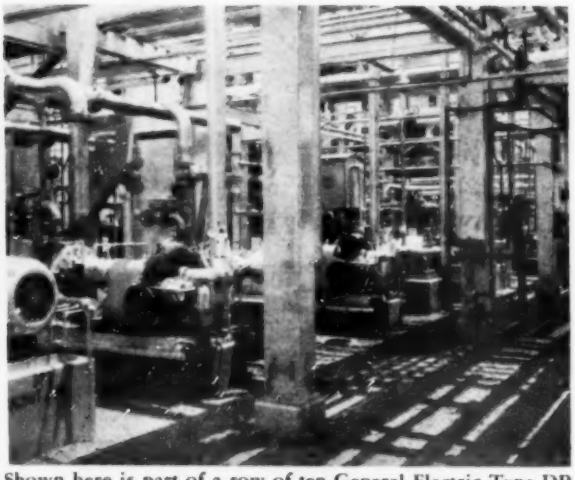


McMurrey Refining Company, Tyler, Texas, installed G-E mechanical-drive turbines throughout their plant to help assure continuous capacity output of 5000 bbls. per day.

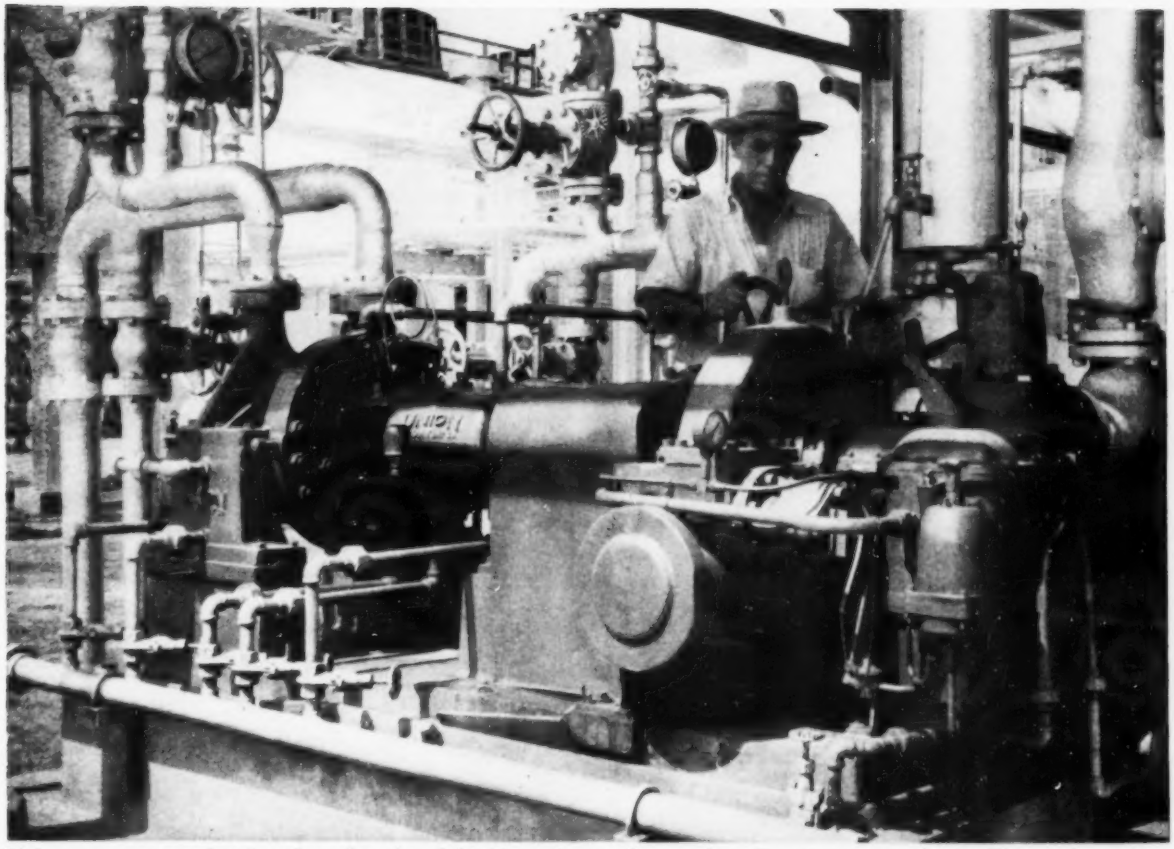
G-E Turbines Save Maintenance,



G-E turbines and motors are paired at McMurrey Refinery to utilize large steam supply efficiently. When process steam demands decrease, surplus steam is economically diverted to turbine drives. These Type DP turbines range from 8 hp to 41 hp.



Shown here is part of a row of ten General Electric Type DP turbine drives and motors, ranging from 9 hp to 48 hp. The many interchangeable parts on these turbines make stocking of spare parts an economical matter.



Maintenance personnel at the refinery have found this General Electric Type DP mechanical-drive turbine, like the many others at the refinery, easy to maintain. This 47-hp turbine at McMurrey Refinery drives a boiler-feed water pump.

Inventory Costs at McMurrey Refinery

Installed to improve steam balance, G-E standard turbines, with many interchangeable parts, also cut inventory costs.

The McMurrey Refinery, Tyler, Texas installed General Electric mechanical-drive turbines to help regulate steam balance. Since process steam demands range from 30% to 70% of available supply, surplus steam is economically diverted to turbine drives.

Time soon proved the many other advantages of G-E turbine drives which were especially designed for the petroleum industry. Mr. Dave Hood, Mechanical Maintenance Foreman at the refinery, states, "With these turbines on the line now for over a year, we're happy to report that they are extremely easy and economical to maintain, requiring very little of our time for maintenance."

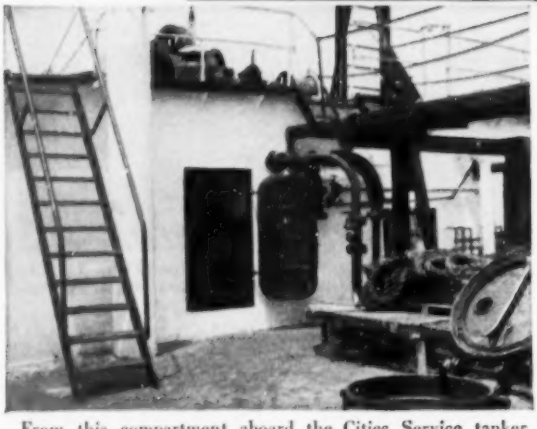
Mr. Hood also said, "Since we have quite a few different sizes and ratings of turbines here, we're particularly pleased with the great number of interchangeable parts on these turbines. It certainly cuts down our inventory problem." Interchangeability of a great majority of the replaceable parts (regardless of hp rating) is a big feature with G-E standard turbine drives, which are paired with motors throughout the refinery to help assure uninterrupted service.

Call in your G-E sales-engineer or write for bulletin GEA-4955A, "A New Standard in Mechanical-drive Turbines." Section 252-58, General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

DRY air is carried by a manifold to all parts of this tank farm at the Cicero, Illinois, blending and packaging plant.

Cities Service safeguards its fine lubricating oils with a blanket of DRY air...



From this compartment aboard the Cities Service tanker, SS Winter Hill, a Lectrodryer feeds DRY air to tanks in which lubricating oil is transported.

Lectrodryers like this one at the Petty's Island Refinery are installed around tank farm to safeguard lubricating oil in storage.

At the refinery and aboard ship, at the tank farm and blending plant, Cities Service Oil Company preserves the high quality of its lubricating oils by forcing storage tanks to breathe DRY air. With this blanket of DRY air over the oil at all times, there's no moisture to cause the oil to deteriorate or form rust to contaminate it.

Lectrodryers* at major points in their production-distribution setup do that DRYing. To find out what Lectrodryers will do for you, write Pittsburgh Lectrodryer Corporation, 332 32nd Street, Pittsburgh 30, Pennsylvania.

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(To obtain more data on advertised products see page 280)

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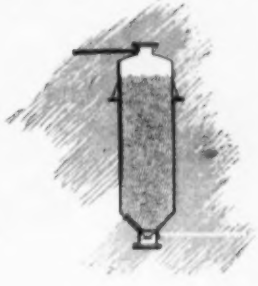
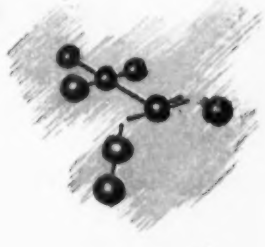
WHAT DO YOU WANT TO PURIFY?

There's an Attapulgus or Porocel adsorbent to fit your process technique for removing odors, colors, tastes, moisture, acids, sulfur, fluorides and unsaturates from process liquids or gases. Materials treated in principal applications are: motor oils and other lubricating, specialty, and technical oils; petrolatums and waxes; aviation and motor gasoline stocks; kerosene; diesel and heating oils.



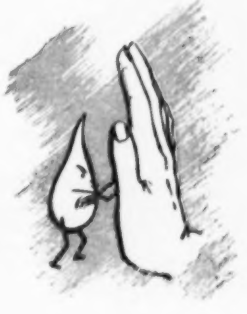
DO YOU HAVE CATALYST OR CATALYST CARRIER NEEDS?

Attapulgus or Porocel sorptive minerals are recognized standards in desulfurization, reforming and isomerization systems—catalytic removal of unsaturates—conversion of sulfides to elemental sulfur—fluid catalyst applications—as catalyst carrier in copper sweetening processes.



WHAT DO YOU WANT TO DRY?

We offer a wide range of reliable, thoroughly proved desiccants for drying air, hydrogen, carbon dioxide, hydrocarbon liquids and gases.

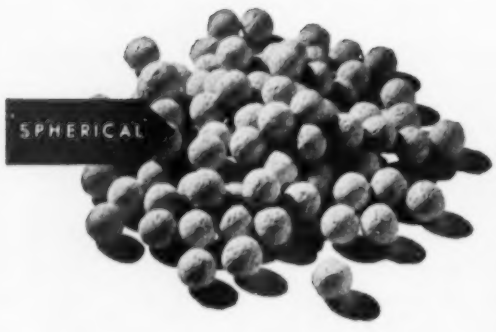


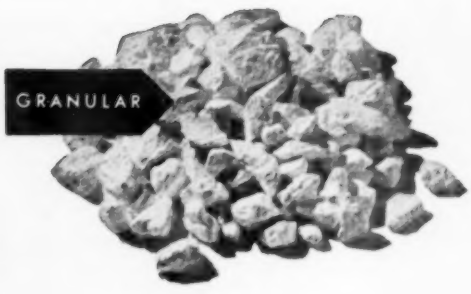
SPECIAL GRADES?

Mine and plant facilities permit prompt and economical production of grades meeting individual customer specifications. Our laboratories and technical staffs welcome the opportunity of assisting in research, development, design and operating problems. Your inquiries are invited.

ATTAPULGUS MINERALS & CHEMICALS CORPORATION · **POROCEL** CORPORATION

Dept. D, 210 West Washington Square, Philadelphia 5, Pa.





HARSHAW

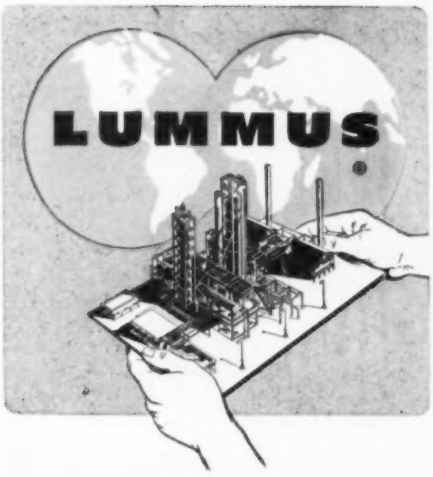
you specify the catalyst

HARSHAW can make it!

• Harshaw has a large production capacity for preformed catalysts. In many cases economies can be realized by having Harshaw manufacture catalysts to specification for Hydroforming . . . Cyclization . . . Oxidation . . . Dehydrogenation . . . Hydrogenation . . . Dehydration . . . Desulphurization . . . Alkylation . . . Isomerization. Typical catalysts and catalytic chemicals are . . . Aluminum Chloride Anhydrous . . . Boron Fluoride Addition Compounds . . . Boron Trifluoride . . . Hydrofluoric Acid Anhydrous . . . Activated Alumina . . . Chrome Alumina . . . Molybdena Alumina . . . Tungsten Alumina . . . Cobalt . . . Copper . . . Copper Chromite . . . Magnesia . . . Nickel . . . Vanadium.

Our experienced technical staff will assist you in developing the best and most economical catalyst. If you have a catalytic process in the development or production stage, a discussion with us may prove beneficial.

THE HARSHAW CHEMICAL CO.
1945 East 97th Street, Cleveland 6, Ohio
BRANCHES IN PRINCIPAL CITIES



...a sign you can believe in

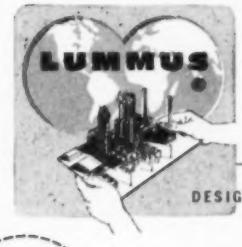
You are apt to see this sign anywhere.

It might be on a bulldozer "hogging out" a raw site for an oil refinery in Europe or the Near East; or on a 100-ton distillation tower en route to South America, Canada, or the Orient; or on the control panel of a petrochemical plant on the Gulf Coast.

It might even be as close as the cover of an engineering study or job proposal lying on your own desk.

For over 50 years it has been the mark of a project in capable hands. It stands firmly on a world-wide record —the designing, engineering and constructing of nearly 700 units of all types for manufacturing the full range of petroleum products, and for making the world's most-needed chemicals and petrochemicals.

It's a good sign to rely on when you buy complete, integrated engineering service for your next project.

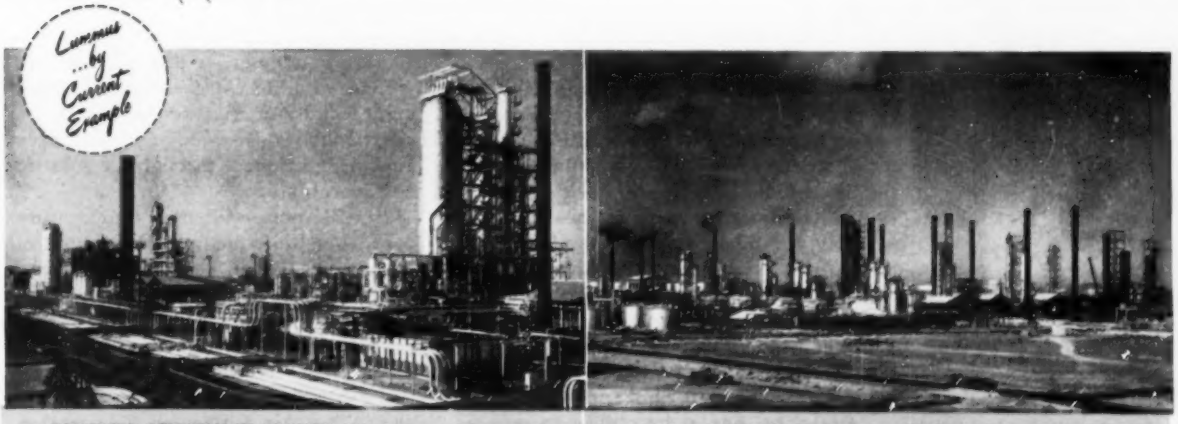


THE LUMMUS COMPANY

385 MADISON AVENUE, NEW YORK 17, N.Y.

HOUSTON • CHICAGO • LONDON • PARIS • CARACAS

DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

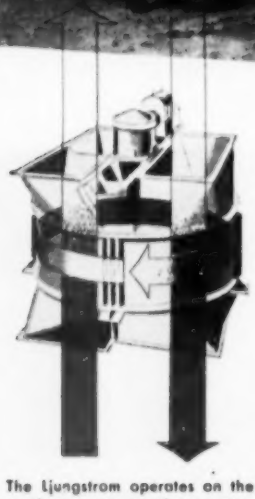


COMPLETE REFINERY IN FRANCE. This is a partial view of Société Générale des Huiles de Pétrole's complete oil refinery at Dunkirk which alone makes available about 1¾ million gallons per day of a full range of petroleum products for French industrial and domestic uses. Practically all processing units in this refinery were designed, engineered and built by Lummus.

COMPLETE REFINERY IN VENEZUELA—a project in which Lummus played a major role by designing and engineering most of the processing units, and constructing all of them. Covering 3,150 acres, this refinery handles 170,000 barrels per day of petroleum—almost one-half of Venezuela's total refining capacity. Owner: Shell Caribbean Petroleum Company.

Get Higher Throughput

Ljungstrom Air Preheater



The Ljungstrom operates on the continuous regenerative counter-flow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.

With the process industries' production at all-time high levels – and climbing higher – here is a timely suggestion that may point the way to significant production increases in your plant – *without adding a single still.*

A Ljungstrom Air Preheater, properly combined with modern draft and burner equipment, can increase still production as much as 25%. At the same time, plugging is so much reduced that production lost to downtime will be astonishingly low.

The value of the Ljungstrom Air Preheater lies in its ability to recover heat normally lost up the stack, and to return a large portion of it to the furnace zone in the form of preheated combustion air. Fuel requirements are drastically reduced and–where furnace capacity permits – throughput goes up considerably.

Furthermore – the finer temperature control possible leads to closer control of the end product. This alone can mean tens of thousands of dollars a year.

Wherever you are replacing, modernizing, or adding new equipment that burns fuel – consider the economies you can get with a Ljungstrom. Call or write The Air Preheater Corporation for complete information.

Wherever You Burn Fuel, You Need Ljungstrom

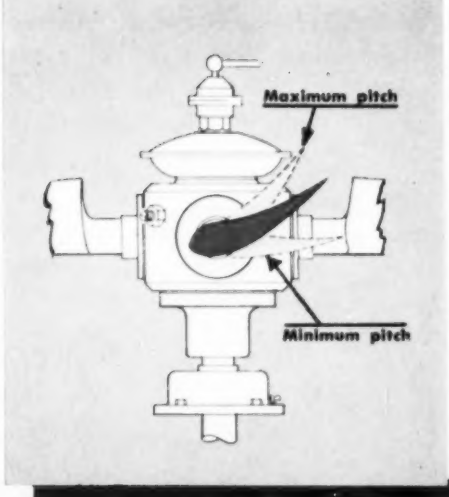
THE AIR PREHEATER CORPORATION 60 East 42nd Street, New York 17, N. Y.

Another NEW DEVELOPMENT by HUDSON

HUDSON
Auto-variable*
PITCH FAN

* patents pending

The Hudson Auto-variable pitch fan allows *automatic* control of cooler outlet temperature, regardless of air temperature, cooler inlet temperature, or heat load. Minute changes in cooler outlet temperatures immediately and automatically change pitch of fan blades increasing or decreasing the air flow across the coolers. This device marks an important advance in use of air for cooling—saving power, eliminating shutters, and smoothing process operations. Auto-variable fans will find wide application in cooling of jacket water and condensing hydrocarbon vapors and steam.



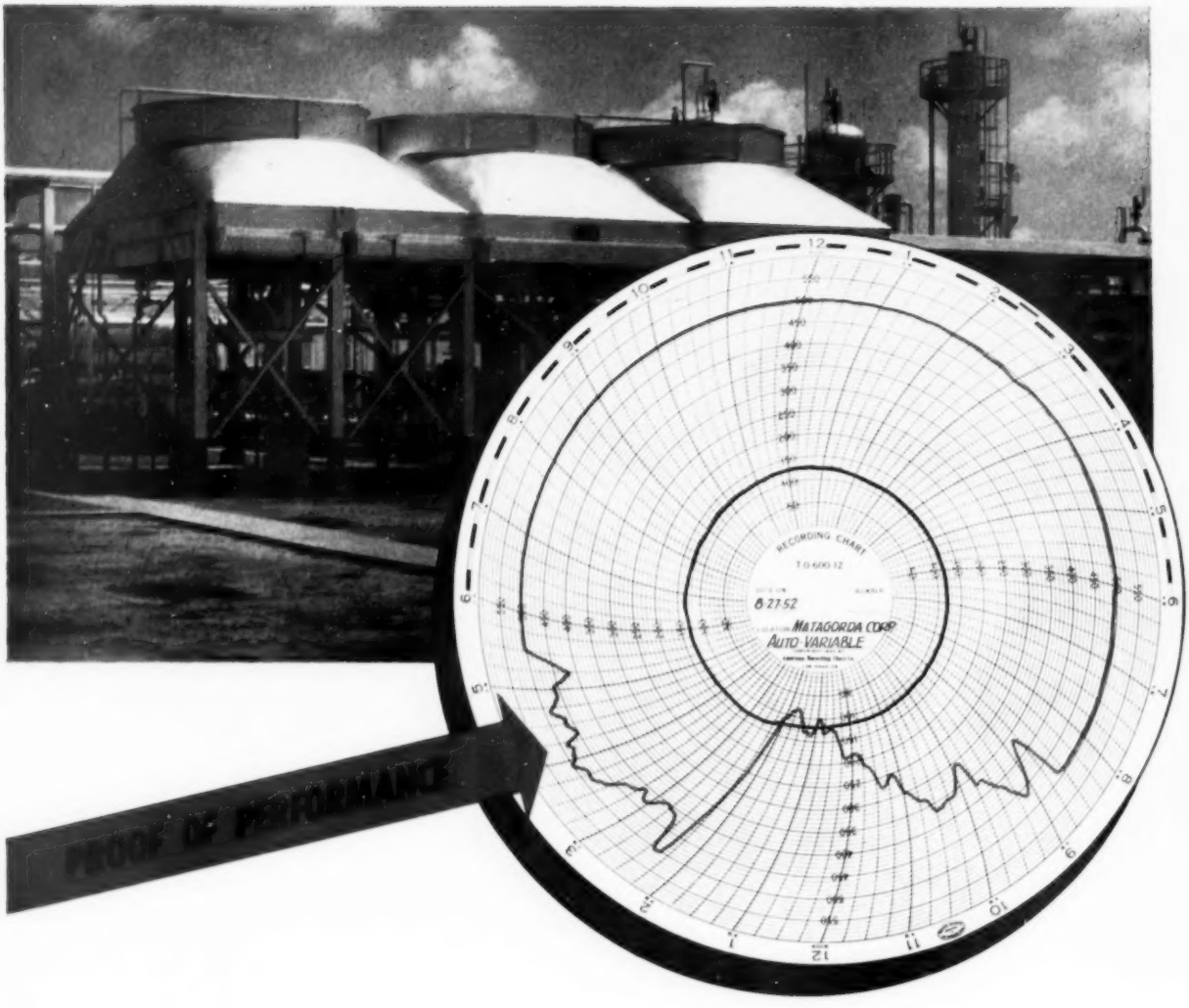
Fan pitch limit adjustment shown from maximum to minimum.

The HUDSON Auto-variable pitch fan . . .

- **Controls temperature.**
- **Saves power.**
- **Reduces cost of control equipment.**
- **Prevents freezing due to cold weather.**
- **Eliminates by-pass piping.**
- **Operates with standard pneumatic instruments on 0-15# air pressure.**

Hudson Auto-variable fans are available in sizes from 6 to 18 foot diameter for use in Hudson Solo-aire air cooled units and in Hudson Combin-aire units.

PROOF OF PERFORMANCE ➡



70 PERCENT SAVING IN POWER

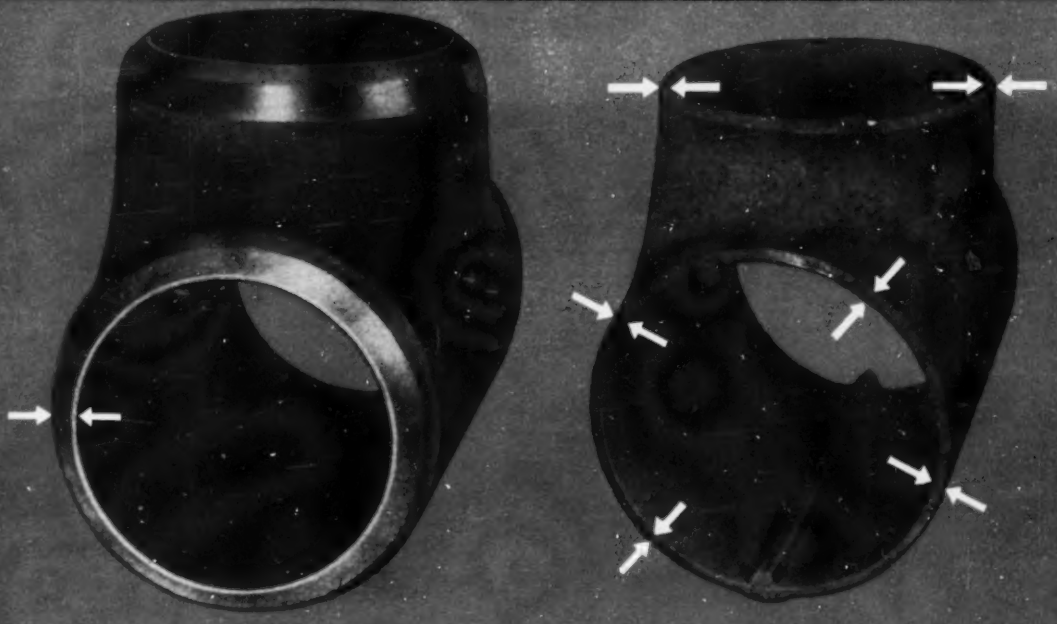
During the 24 hour period the measured electric power consumption was 30% of that which would have been required had the blade pitch been at a constant maximum.

Shown above is a facsimile of a chart taken from a recording instrument used in controlling temperature on a Solo-aire gasoline condenser installed in Matagorda Corporation plant near Bay City, Texas. The outer line (red) shows the fan pitch variation required to maintain constant stream temperature (black line).

Despite air temperature variation from 72°F to 100° F, and despite changes in the heat load, the outlet temperature from the cooler was held constant throughout the 24 hour period.

HUDSON
ENGINEERING CORPORATION
FAIRVIEW STATION • HOUSTON, TEXAS

EVIDENCE OF SUPERIORITY IN *Corrosive Service*



BEFORE *Midwest 6" extra heavy weight, carbon steel tee showing original wall thickness of tee at right before it was accidentally subjected to corrosive conditions.*

AFTER *When straight pipe in line had failed from corrosion, this Midwest tee was removed. Note amount and uniformity of wall thickness remaining.*

A valve leaked or somebody opened it by mistake . . . so the Midwest Tee shown above was subjected to dilute hydrofluoric acid in addition to its normal service in a 300° F. hydrocarbon line on an alkylation unit.

The highly corrosive acid caused failure of the straight pipe . . . so the entire line had to be replaced. When cut out of the line, the Midwest Tee was found to have a considerable (and uniform) wall thickness. There was no selective corrosion and the weld held up even better than the parent metal.

This was not special alloy made to resist corrosion, but regular Grade "A" carbon steel . . . the same as the new tee shown left above. We do not, of course, recommend carbon steel for corrosive conditions, but, in emergency, it gives good account of itself.

The exclusive Midwest manufacturing process produces fittings of superior metallurgical properties. The metal is worked in compression . . . it is not stretched or extruded, and distribution is uniform. After forming and welding, the fitting is stress-relieved. For further information, write us for a copy of Catalog 48.

MIDWEST PIPING & SUPPLY CO., INC.

Main Office: 1450 South Second Street, St. Louis 4, Mo.

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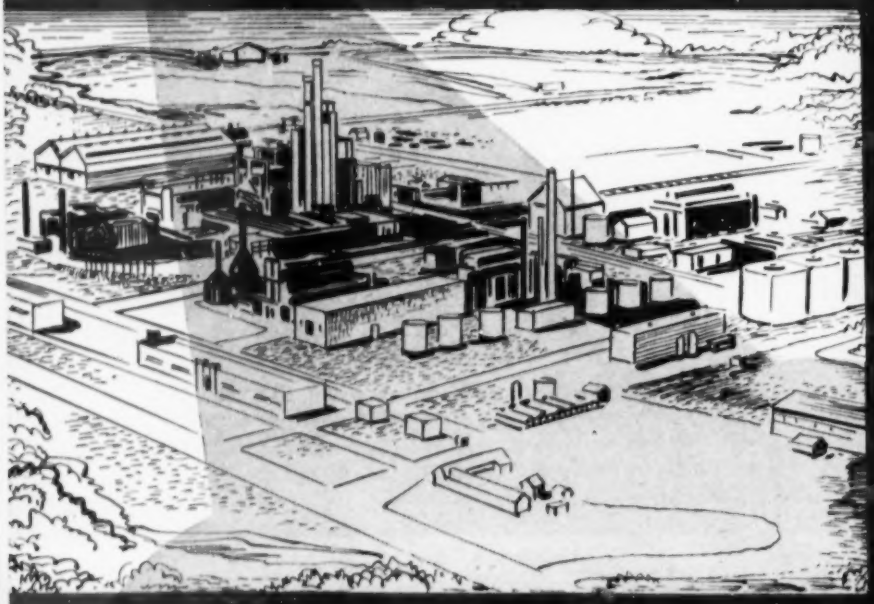
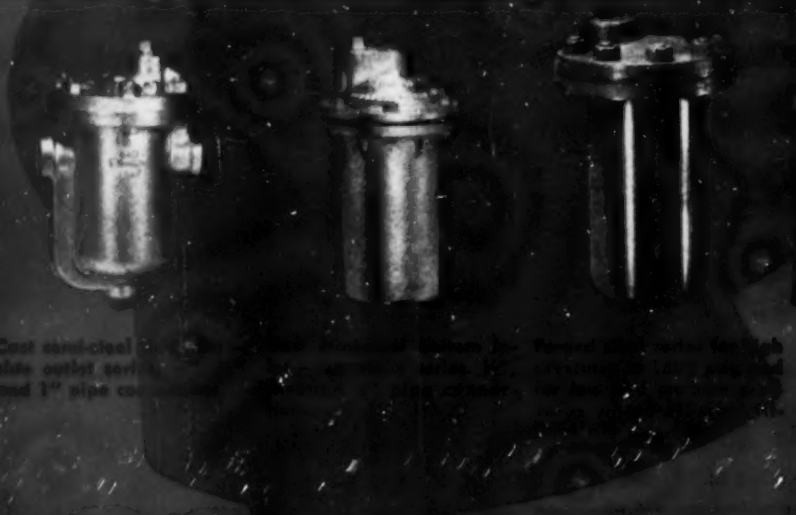
MIDWEST WELDING FITTINGS

IMPROVE DESIGN AND REDUCE COSTS

A STEAM TRAP CASTS A





THINGS STEAM TRAPS AFFECT

1. HEAT-UP OR START-UP TIME
2. RATE OF PRODUCTION
3. STEAM WASTE
4. FUEL WASTE
5. CONTINUITY OF OPERATION
6. MAINTENANCE COST

ARMSTRONG MACHINE WORKS

It Pays to Specify

ARMSTRONG

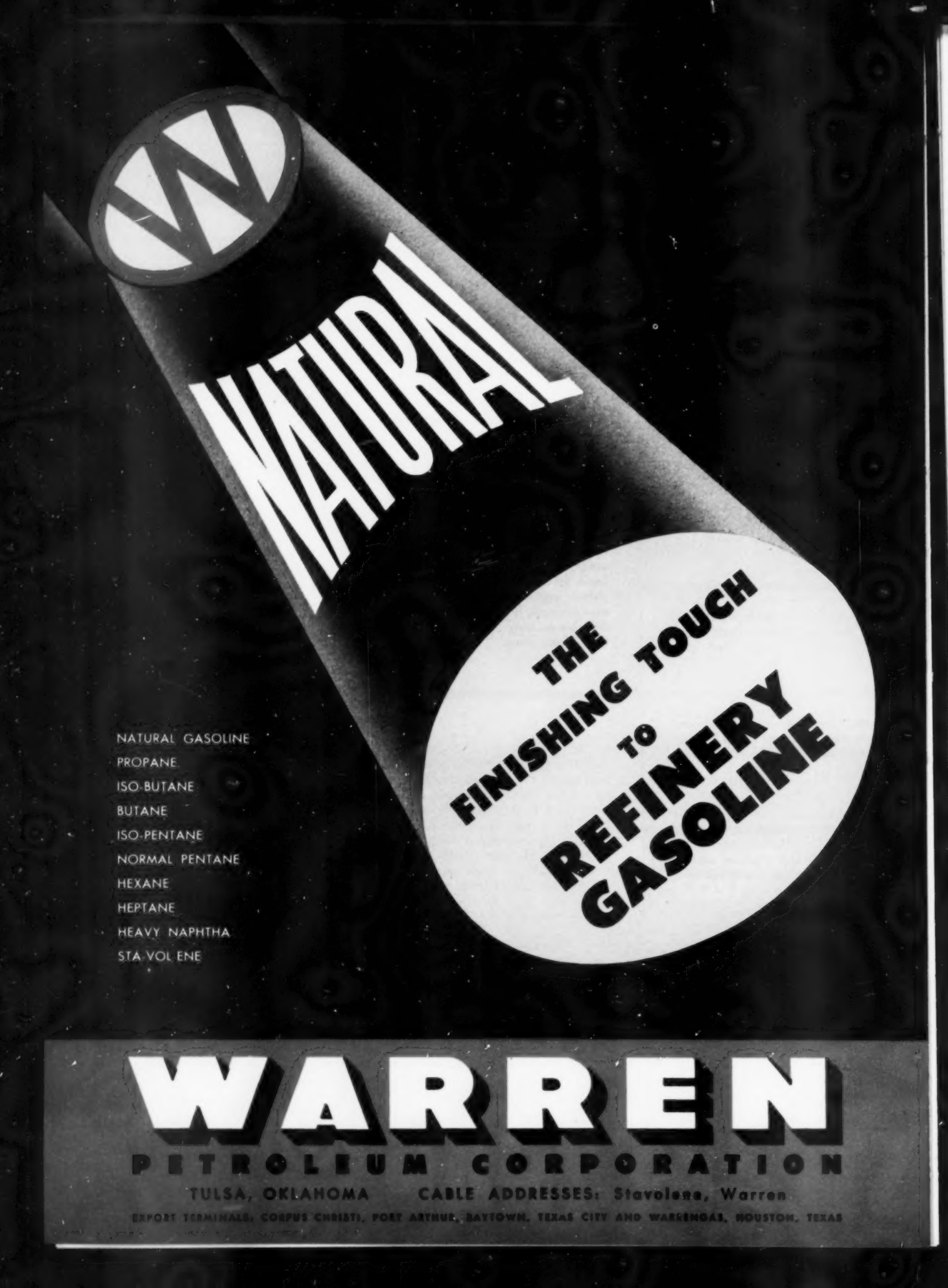
MIGHTY BIG SHADOW

REASON	HOW ARMSTRONG TRAPS MEET THE NEED	EXAMPLE
When steam is turned on, large amounts of condensate *and air* must be removed before equipment heats up.	Condensate *and air* removed as fast as they reach trap. Reliable data insures you get trap with adequate safety factor to meet conditions.	*40 Minute Faster Heat-up*—drying oven at pharmaceutical plant heats up 40 minutes sooner with Armstrong "Blast" traps.
Quick heat-up, maximum temperatures essential for maximum output.	Air which reduces temperature and heat transfer discharged automatically; condensate discharged at steam temperature; equipment kept *full* of hot, dry steam.	*30% Greater Output* — jacketed kettles produce 30% more at Canadian plant since changing to Armstrong traps.
When steam gets past traps, boiler capacity may be inadequate—this is bad even if you could afford the fuel waste.	When steam floats the bucket the trap closes. No steam ever reaches discharge orifice, even when there is no condensate load. Heat treated chrome steel valve parts, precision ground and lapped, resist wire drawing and wear, stay leak tight for a long, long time.	*Steam Savings Eliminate Need for New Boiler*—chemical plant shelves plans to buy larger boiler after installing Armstrong Traps.
Why burn fuel to generate steam that does no useful work . . . blows through traps, for example?		*33⅓% Reduction in Fuel Bill* — after trapping vats with Armstrongs at Missouri plant.
When traps are inoperative or down for repairs, unit being drained may be "off the line."	Nothing to clog, seize, stick or collapse! Large orifice. Self-scrubbing action cleans out ordinary dirt and scale. "Frictionless" leverage with wear points heavily reinforced for long life. Hardened chrome steel valve and seat. Wear and corrosion-resistant stainless trim.	*Maintenance Time Cut 30%* — Illinois user says, "Unequalled dependability, simplicity of design means repairs can be made quickly" (with minimum equipment downtime).
Traps that don't "wear well" take a lot of manhours for repair.		*50% Less Trap Maintenance* — only half as many manhours devoted to traps since installing Armstrongs throughout large Midwestern plant.

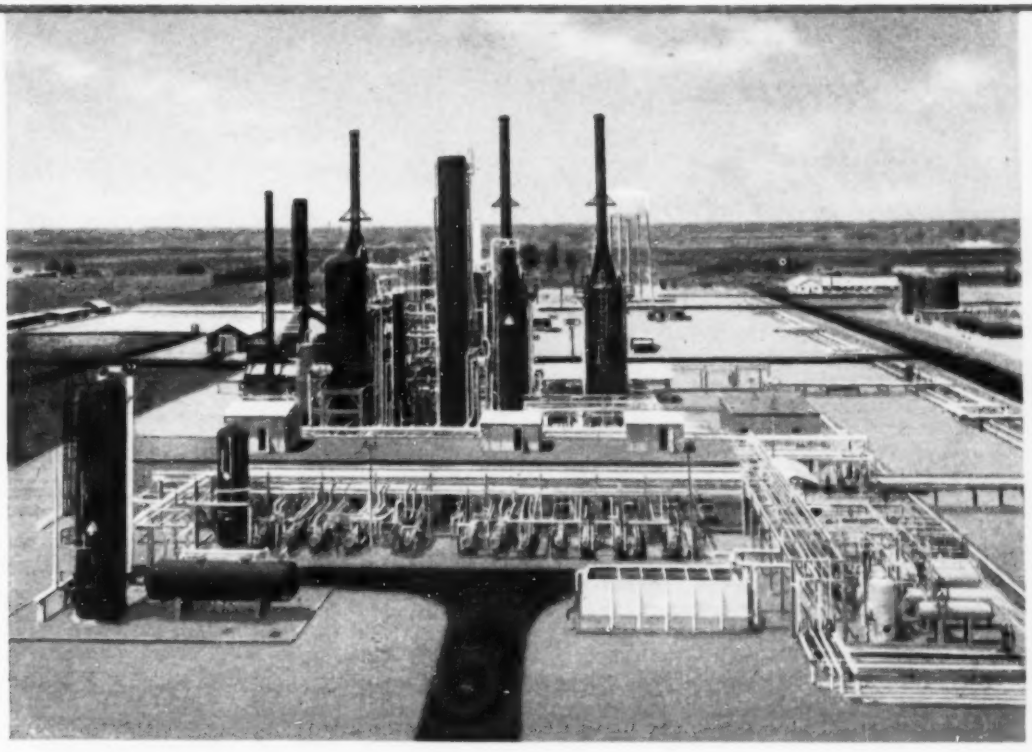
SEND FOR THE *NEW* ARMSTRONG STEAM TRAP BOOK

Fresh off the press — 44 pages of practical trapping data. Tells how to select traps for nearly *every* class of equipment; explains safety factors; gives prices, physical data, service pressure ratings of Armstrong traps; includes recommended installation, maintenance and trouble-shooting practices; contains many time-saving charts and tables — condensate rates, trap capacities, trap size recommendations and others. For your free copy, call your local Armstrong Representative or write to Armstrong.

STEAM TRAPS


NATURAL
THE FINISHING TOUCH TO REFINERY GASOLINE
NATURAL GASOLINE
PROPANE
ISO-BUTANE
BUTANE
ISO-PENTANE
NORMAL PENTANE
HEXANE
HEPTANE
HEAVY NAPHTHA
STA-VOL-ENE
WARREN
PETROLEUM CORPORATION
TULSA, OKLAHOMA
CABLE ADDRESSES: Stavolene, Warren
EXPORT TERMINALS: CORPUS CHRISTI, PORT ARTHUR, BAYTOWN, TEXAS CITY AND WARRENGAS, HOUSTON, TEXAS

NEW HORIZONS



The Crude Distillation and Vis-breaking Unit of Sarnia Refinery, designed by Badger Process Division, processes 20,000 barrels per day of Alberta crude oil

Sarnia Refinery of Canadian Oil Refineries, Limited, is the first large, integrated refinery in Canada built for processing Canadian crude oil. It brings to this rapidly growing region the last word in technological progress in the field of petroleum refining. Such progress means better quality of product and greater efficiency in operation. Design and construction of the refinery were managed by Stone & Webster Canada Limited, utilizing the facilities of Stone & Webster Engineering Corporation.

STONE & WEBSTER ENGINEERING CORPORATION

Affiliated with

STONE & WEBSTER CANADA LIMITED

E. B. BADGER & SONS (Great Britain) LTD.

Funny Thing — he really had something!

"The miracle of the century!" he would rant. "The most sensational discovery of all time! Positively guaranteed to restore natural color to the hair, free you from the crippling clutches of rheumatism, break the most stubborn fever, cure coughs, colds, backache and liver complaints!

"Now to you, my friends, as a special introductory offer, this bottle, which usually sells for $15 and more is yours . . . not for $10, not for $5, but for the amazing low price of . . ."

Pure hokum, of course. For little did the medicine man realize, when he bottled crude oil out of the ground, that his most extravagant claims could not do justice to the real capabilities of this "liquid gold." He really had something—and didn't know it.

His "Rock Oil Nostrum" really *was* the miracle of the century!

From his giant economy-sized bottle have since flowed the oil and gasolene that made the automobile possible . . . the lubes and greases that have enabled machines to take over man's back-breaking jobs. From that miraculous bottle have come asphalt, insecticides, wax, plastics, literally hundreds of useful products—even drugs "to cure coughs, colds, backache and liver complaints!"

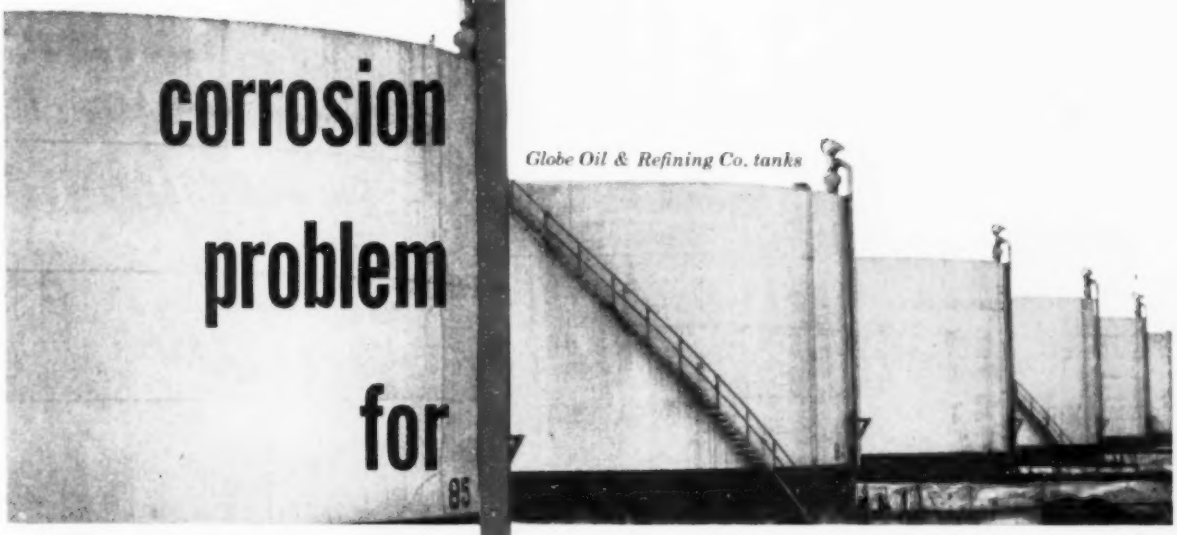
Cities Service, an oldster in the oil business, has been responsible for many of these petroleum miracles. It is pouring more products out of that bottomless bottle every day. The men in its Miracle Department (petro-chemists, they're called), say that oil has just been flexing its muscles—we haven't even begun to see all it can do.

To put it very simply: You and I live better, more comfortably, because petroleum was discovered. And that's no hokum!

CITIES SERVICE

Quality Petroleum Products

SANTOLENE C solves corrosion problem for The Globe Oil & Refining Co.



Globe Oil & Refining Co. tanks

Prior to November 1950, The Globe Oil & Refining Co., Lemont, Illinois, had the usual problem of corrosion in blending tanks.

Today, the corrosion problem is no more, because the Company is using sufficient Monsanto Santolene C, added with inhibitor and metal deactivator as regular and premium gasolines are treated in the blending tanks. Santolene C requires no additional equipment at the Globe Refinery.

Santolene C is product-soluble, burning completely with the fuel. Diesel and gasoline engine tests prove that Santolene C does not reduce engine cleanliness . . . causes no injector fouling . . . has no adverse effect on any factor of engine performance.

If you have a corrosion problem with light petroleum products in storage or transit, investigate Santolene C. For information, write, wire or phone MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, 800 North Twelfth Blvd., St. Louis 1, Missouri.

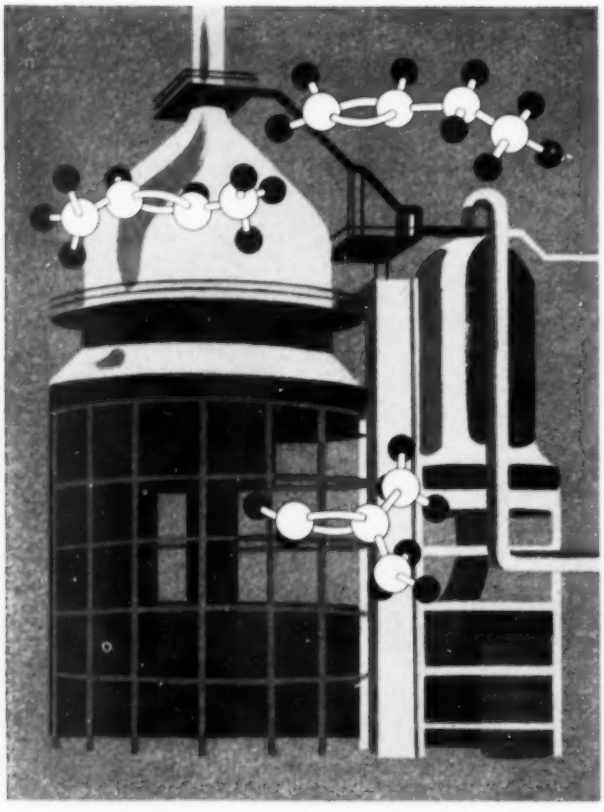
Santolene: Reg. U. S. Pat. Off.

SANTOLENE C

MONSANTO
CHEMICALS – PLASTICS

SERVING INDUSTRY . . . WHICH SERVES MANKIND

(To obtain more data on advertised products see page 280)



Meeting New Markets For Light Hydrocarbon Unsaturates

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FOR THE EVER-EXPANDING PETROCHEMICAL MARKET MAXIMUM YIELDS OF UNSATURATED HYDROCARBONS FROM CATALYTIC CRACKING OPERATIONS ARE NEEDED. FILTROL'S SR GRADES AND FILTROL'S REGULAR LINE OF FLUID AND PELLETED CATALYSTS OFFER OPPORTUNITIES FOR PRODUCING HIGHER YIELDS OF UNSATURATED C_3 AND C_4 HYDROCARBONS, WHILE MAINTAINING GASOLINE YIELD.

BOOKLET S-5 ON BUTYLENE YIELD PREDICTION AVAILABLE ON REQUEST.

Filtrol*

FILTROL CORPORATION

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CATALYSTS AND ADSORBENTS

*T. M. REG. U. S. PAT. OFF.

ORBIT VALVES®

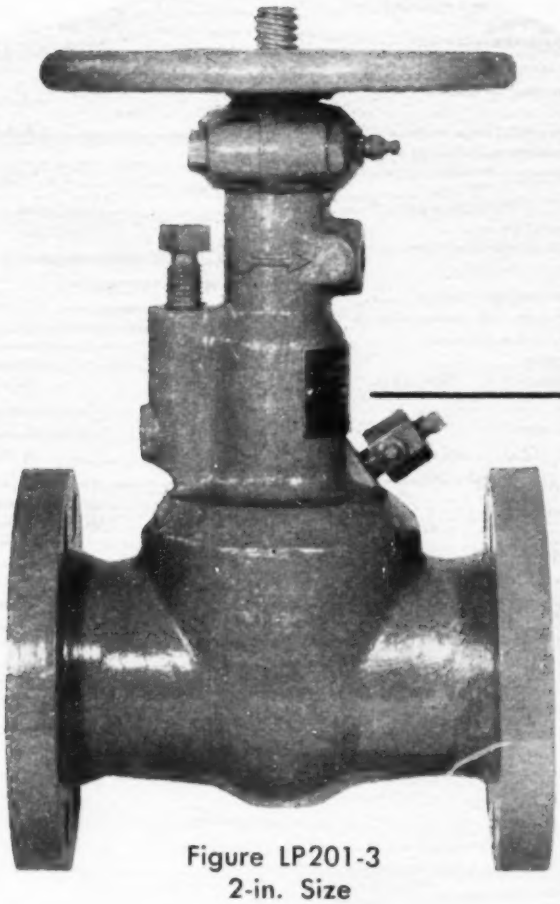

Figure LP201-3
2-in. Size

METHANE

ETHANE

PROPANE

BUTANE

for Field Processing, Natural Gas and L.P. Gas Plants

ORBIT FORGED STEEL LP GAS VALVES are available in sizes: 1", 1½", 2", 2½", 3" and 4". ASA Ratings 150 lb. Class to and including ASA 2500 lb. Class; Screw and Flanged Ends. Maximum Rated Working Temperature 250° Fahrenheit.

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Top uniformity and dependability are available to you in Davison's microspheroidal (M-S*) or ground (DA-1*) synthetic fluid-type cracking catalysts. The accompanying photomicrographs show the physical characteristics of the DA-1 and new M-S catalysts produced in Davison's Cincinnati plant. Uniform physical and catalytic characteristics result from Davison's modern facilities and years of technical experience and research. Experienced Davison Field Service Engineers—complete laboratory facilities—are all part of Davison Dependability—Dependability with the big "D".

*T.M.T.D.C.C.

Progress Through Chemistry

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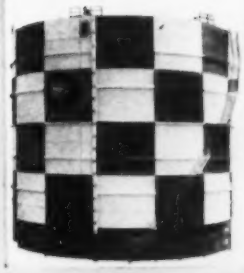
Baltimore 3, Maryland

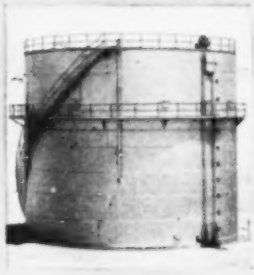
PRODUCERS OF: CATALYSTS, INORGANIC ACIDS, SUPERPHOSPHATES, PHOSPHATE ROCK, SILICA GELS, SILICOFLUORIDES AND FERTILIZERS

users of chemical process



and industrial gases

get rid of



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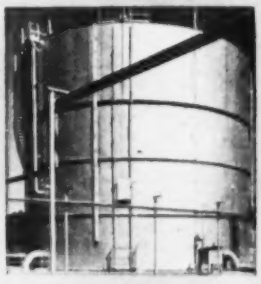
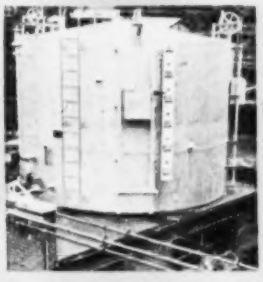
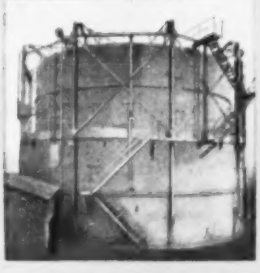
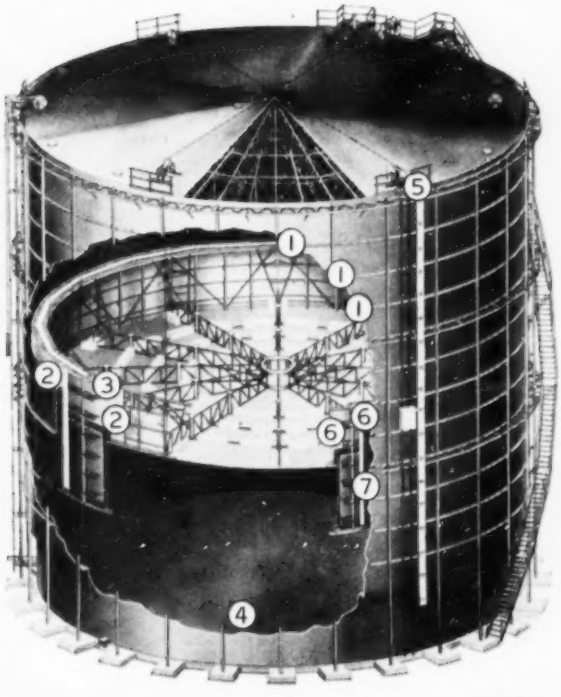
by GENERAL AMERICAN

More than 50 users of Wiggins Gasholders can now testify to the remarkable savings in operating costs and maintenance expense which only this 100% dry seal gasholder (no water, no tar, no grease) gives them. Write for full information.









1 TOP SECTION OF SHELL COMPLETELY VENTILATED

2 WIDE CLEARANCES SIMPLIFY OPERATION

3 GAS-TIGHT FRICTIONLESS SEAL NOT AFFECTED BY WEATHER

4 PISTON RESTS ON BOTTOM—LESS THAN ½ OF 1% FOR PURGING

5 LEVELING DEVICE—INDEPENDENT OF SIDE WALL—KEEPS PISTON LEVEL

6 FENDERS PREVENT ALL TENSION IN SEAL

7 SHELL IS GAS-TIGHT UP TO SEAL CONNECTION

PISTON RISES NEARLY TO TOP—MINIMUM OF WASTE SPACE
CAN BE BUILT ANY SIZE • NO CONTAMINATION OF GAS

CONVERSION EASY—OFTEN ADDS CAPACITY

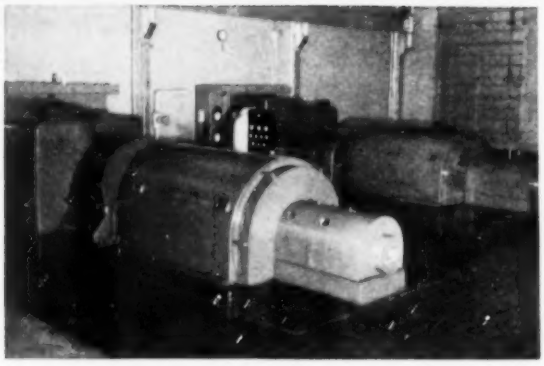
Your old gasholder can be quickly converted to a Wiggins type with all the Wiggins advantages.

GENERAL AMERICAN TRANSPORTATION CORPORATION

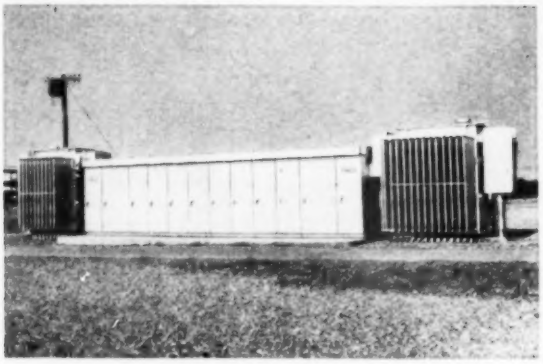
135 South LaSalle St. • Chicago 90, Illinois

OFFICES IN PRINCIPAL CITIES

Export Dept.: 10 East 49th Street, New York 17, New York
Plants: Birmingham, Ala. • East Chicago, Ind. • Sharon, Pa.
In Canada: Toronto Iron Works, Ltd., Toronto, Ontario

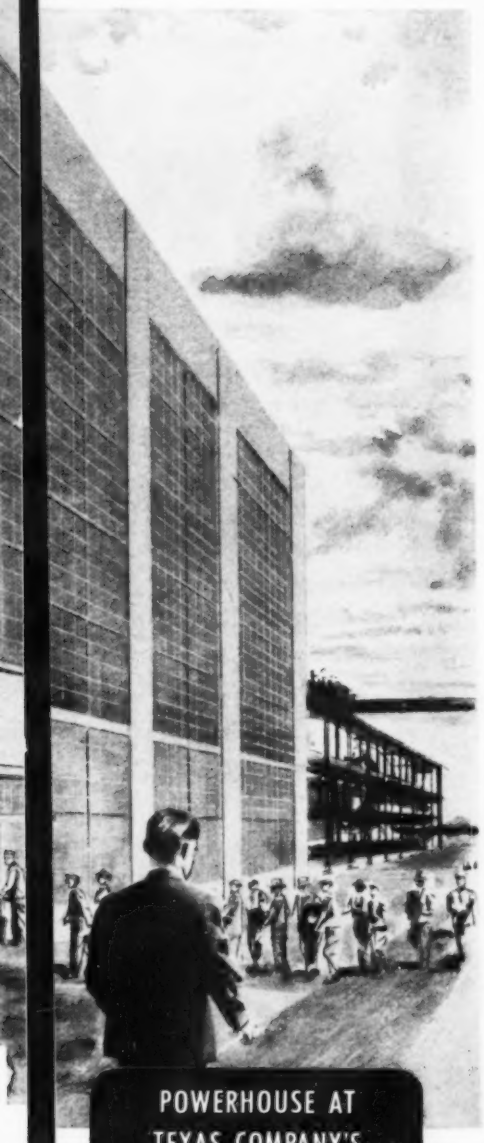


Power is supplied by two Westinghouse Turbine-Generators—plus a stand-by tie-in with utility power. From here, power is sent through *dual feeders* at *high voltage* to substations and load centers throughout the plant.



Each substation is complete with switchgear, transformers and circuit breakers—for redistribution of low-voltage power. This method makes the system highly flexible and dependable and improves voltage regulation.

Here's how *Power System Planning* pays off at Eagle Point Refinery



POWERHOUSE AT TEXAS COMPANY'S NEW EAGLE POINT, N. J., REFINERY

When The Texas Company built their new refinery at Eagle Point, New Jersey, they planned their power system carefully—and had Westinghouse help. They developed a system that's outstanding in dependability . . . in efficiency . . . and in flexibility for future expansion. Here's how they did it.

Refinery has two sources of power

Power is generated by two dependable Westinghouse Turbine-Generators (7,500 kw each). There's also a standby tie-in with the local utility—so that in an emergency they can immediately switch to utility power.

Twin power routes through the plant

From the turbines, power is sent to substations and load centers located throughout the plant. Each of these units has a dual feed. If there's trouble on one line, they switch to the other feeder.

Flexible system for easy expansion

This power distribution system is highly flexible. Suppose they want to expand the plant or add new machinery. All they do is add another substation. The rest of the system need not be disturbed.

High-voltage distribution saves money

In this modern system, each substation receives power at high voltage (13,800 volts). This cuts down on transmission losses. It improves voltage regulation throughout the plant.

Call in Westinghouse for your refinery needs

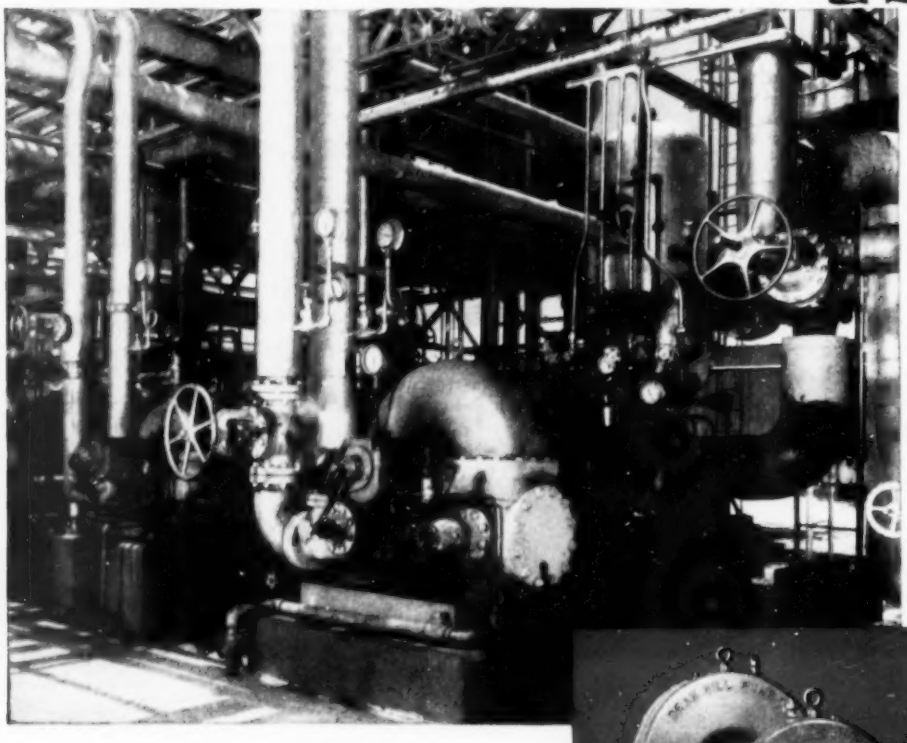
Westinghouse has had a great deal of experience in refinery power systems. We'd like to work with you and your engineers on your next project. When you're thinking about building or expanding, call in Westinghouse early. Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pennsylvania. J-94884

YOU CAN BE SURE...IF IT'S Westinghouse

EQUIPMENT FOR THE PETROLEUM INDUSTRY

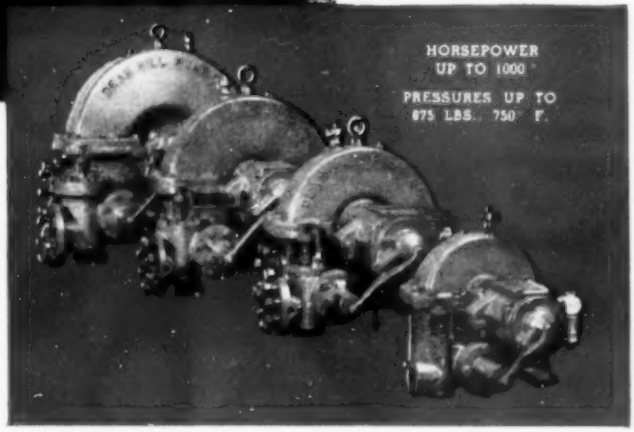
How to stretch a "Power Penny"

You'll never know how much power a penny will buy until you get Dean Hill Steam Turbines on the job. Their super rugged construction, their service-engineered design, their low maintenance, their remarkable power-producing ability all add up to *more power per penny.*



POWER AT WORK

Here are Dean Hill Type DH Steam Turbines at work driving centrifugal pumps at Bay Petroleum Corporation's Chalmette, La. refining operation.



DEAN HILL TURBINES are specifically designed for operation at medium steam pressures. Since they are the single stage, double impact type, low steam consumption is a tremendous economy feature. Steam rates are excellent under these conditions. Get full details and specifications. Write today.

DEAN HILL PUMP COMPANY

Pump and Turbine Engineers Since 1895

INDIANAPOLIS 7, INDIANA

Chicago • New York • San Francisco • Boston • Denver • Albuquerque • El Paso • Salt Lake City • New Orleans • Philadelphia • Tulsa • Los Angeles • Pittsburgh • Houston • Dallas St. Paul • Toledo • Cleveland • Grand Rapids • Birmingham, Ala. • Louisville • Memphis • Nashville • Richmond • Bogota, Col. • Mexico City • Montreal • Reading, Pa. • The Hague, Neth.

NEW ARQUADS

Save Money in Oil Recovery !

Reduce corrosion rate up to 99%
Effectively control bacteria and algae growth

Two new Armour products have proven extremely valuable in controlling both corrosion and bacterial-algae growth in oil recovery operations. Arquad S-2C and Arquad 2C have produced amazing results in solving two of the most troublesome problems of the industry, corrosion and the danger of plugging the sand face by corrosion products and bacterial-algae growth.

ARQUAD S-2C

In an eastern Oklahoma flood system, Arquad S-2C reduced the rate of corrosion 99.5%. In another system in eastern Kansas, the rate of corrosion was reduced 95% by the same chemical. Both sites reported complete bacteria and algae control.

Arquad S-2C is a surface-active quaternary ammonium compound, which is strongly adsorbed on metal surfaces, thereby protecting the surface from attack by corrosive liquids. Its powerful bactericidal properties have been verified by extensive laboratory and field tests.

ARQUAD 2C

This chemical is similar to Arquad S-2C in corrosion control properties, and is recommended for use where bacteria and algae growth do not offer extensive problems. For instance, a sour crude producing well in west Texas reported 93% reduction in rate of corrosion after introduction of Arquad 2C. Economy is one of the most important reasons for using this potent chemical, since corrosion control treatments cost about *one-half* the average of similar treatments using competitive inhibitors.

For your free copy of a new bulletin on control of corrosion and algae in oil recovery operations, fill out and mail the coupon today. At the same time, check the coupon for samples of both Arquads for your own testing and evaluation. Prices will be quoted on request.

"Arquad" is a trade name registered by Armour and Company

MAIL THIS COUPON TODAY

Gentlemen: Please send me the following:

☐ Tech. Bulletin E-6 ☐ Sample of Arquad S-2C
☐ Sample of Arquad 2C

*Name*_____

*Title*_____

*Firm*_____

*Address*_____

*City*_____ *Zone*____ *State*_____

ARMOUR CHEMICAL DIVISION

Armour and Company • 1355 W. 31st St. • Chicago 9, Ill.

TRADE PAPER EDITION
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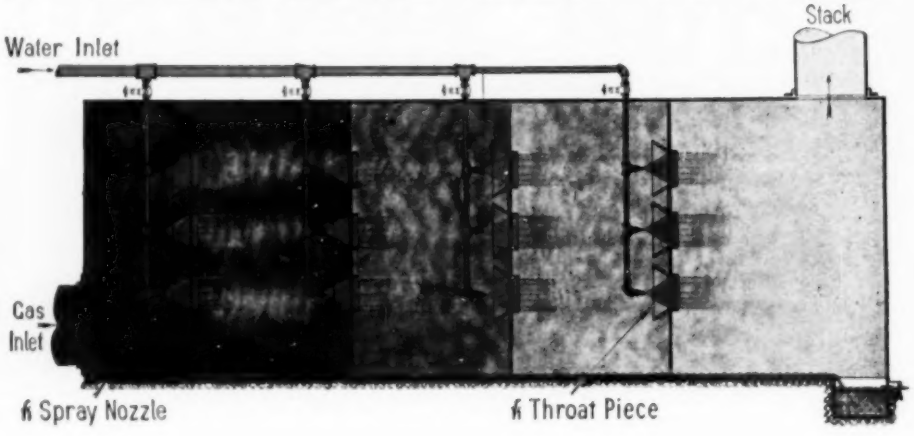
ENGINEERING News

JET APPARATUS • HEAT TRANSFER EQUIPMENT • STRAINERS • CONDENSERS AND VACUUM PUMPS • OIL BURNING EQUIPMENT • ROTAMETERS • FLOW INDICATORS • RADIATOR TUBES • VALVES • SPRAY NOZZLES AND ATOMIZERS • GEAR PUMPS • DESUPERHEATERS

HERE'S HELP IN SCRUBBING GASES OR FUMES



SK Gas Scrubbers are gaining wide application in the petroleum and refining industries because: (1) they have a high scrubbing efficiency rating; (2) they require little maintenance.

These scrubbers will handle gas containing wettable solids and condensable gases as well as gases and solids which can be cleaned by obtaining a chemical reaction between the gas or solids and selected spray liquid.

To meet varying requirements, two types are manufactured by SK—the "Packaged" Gas Scrubber and the Gas Scrubber System. Component parts of both types include the scrubber box, SK Spray Nozzles and Throat Pieces.

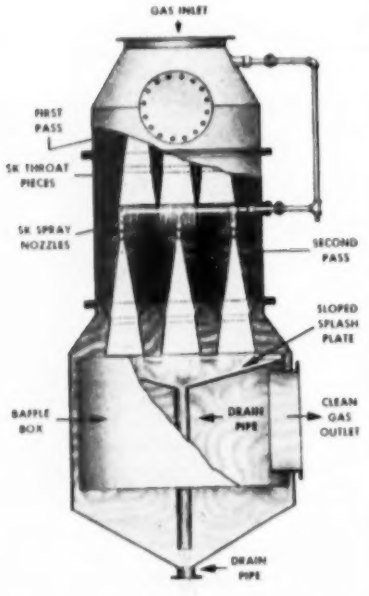


Fig. 4031. SK "Packaged" Gas Scrubber Unit

The Fig. 4031 "Packaged" Gas Scrubber is supplied as a unit and includes an integral separator for separating spray liquid after scrubbing. For Gas Scrubber Systems, SK furnishes spray nozzles and throat pieces and the customer builds the scrubber box to fit the location and requirements. Boxes can be constructed of wood, steel, concrete or other suitable materials, depending upon scrubbing requirements.

The scrubber box, enclosing all components, is divided into compartments or "banks". The number of banks and throat pieces and spray nozzles per bank are determined by the volume and characteristics of the gas and the scrubbing efficiency desired.

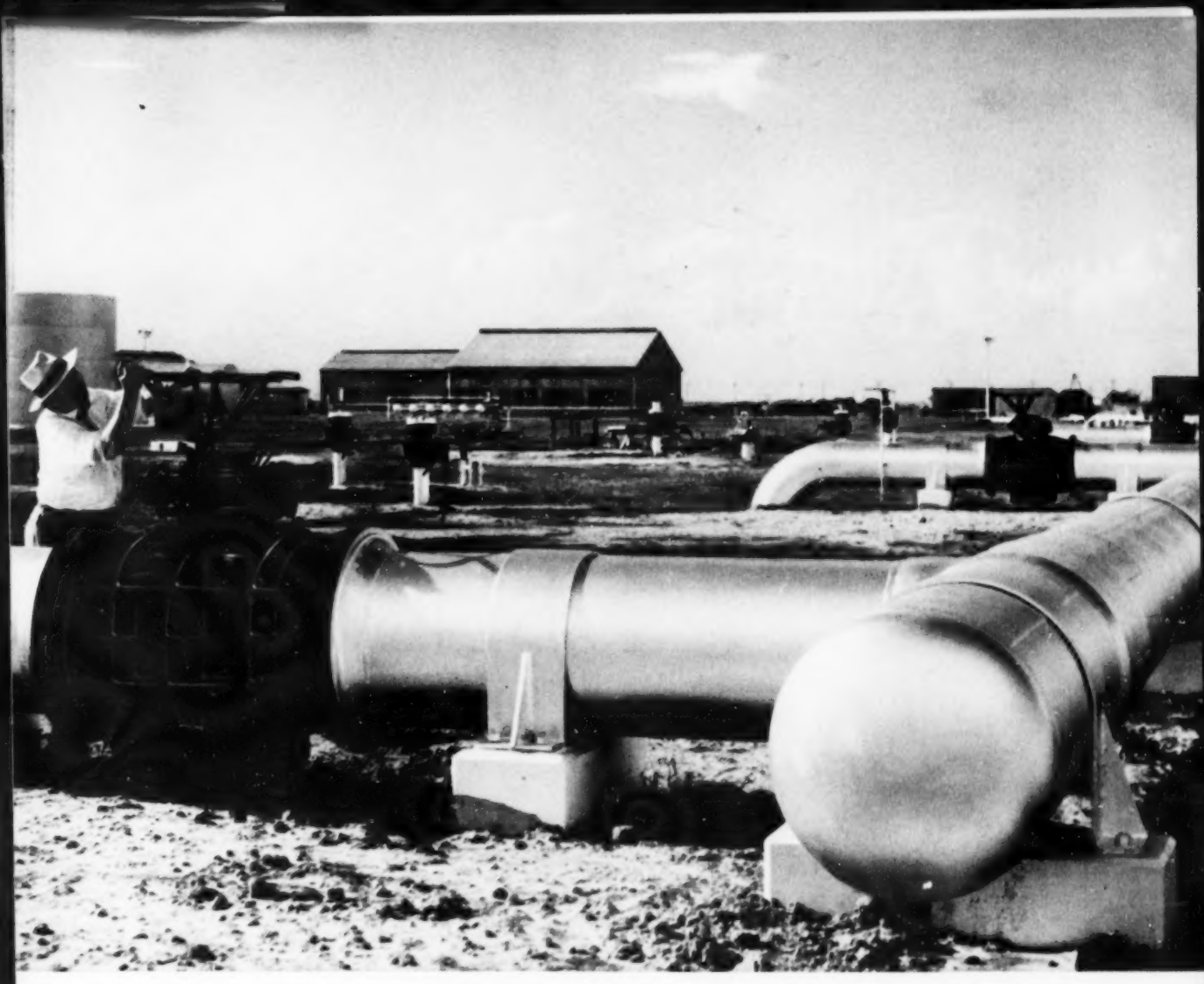
Both types of SK Gas Scrubbers operate on the same principle to handle and wash gases. The gas enters the scrubber through an inlet pipe. The suction action of the spray from the nozzles draws the gas into the throat pieces of the first bank in the scrubber, where the liquid and gas are thoroughly mixed. The mixture is discharged into the second bank where it is again entrained and forced through the throat pieces. When the gas leaves the last bank of the scrubber, it has been washed and cooled and it is then discharged through the outlet pipe.

Advantages of SK Gas Scrubbers are: (1) maximum contact between spray liquid and gas; (2) minimum pressure loss; (3) high scrubbing efficiency; (4) low maintenance.

If you want to control gases or fumes, you'll want a copy of Bulletin Supplement 4-RA. It contains full details on SK Gas Scrubbers. We'll be glad to send you a copy on request.

SCHUTTE and KOERTING Company
Manufacturing Engineers
23 CORNWELLS HEIGHTS
BUCKS COUNTY, PA.
Representatives in Principal Cities

(To obtain more data on advertised products see page 280)



WHEN YOU

Standardize on Nordstrom Valves
You Standardize on Dependability

Whatever the service, whatever the size of the line, write Nordstrom valves into your standards. That way, you can make your first valve installation in any spot a permanent one.

Rockwell Another Rockwell Product | **Built Nordstrom Valves**

LUBRICANT SEALED TO KEEP UPKEEP DOWN

A $150 Valve with a $5,000,000 Job

Somewhere in almost every plant, somewhere in almost every line of flow, there is a key valve—a valve that *must* operate in an emergency.

Often one small valve that costs only a few dollars protects plant investment running into millions and human life beyond price.

Take the case of the valve shown here. This is the control valve which actuates the cylinder controlled Nordstrom valves in case of emergency, and divorces the compressor station from the main line. It closes the inlet and outlet of the station and opens the main line valve.

Most often a key valve like this will be a Nordstrom. Because Nordstroms perform so well in key spots . . . because any piping system is only as good as the valves that control it, naturally Nordstrom valves have been specified for thousands of petroleum, gas, chemical and general industrial services.

The Nordstrom record of dependability and low cost is the best recommendation you could ask. Rockwell Manufacturing Company, 400 N. Lexington Ave., Pittsburgh 8, Pa.

Rockwell Built

Another Rockwell Product **Nordstrom Valves**

LUBRICANT SEALED TO KEEP UPKEEP DOWN

men over 45

More than six times as many men of your age will die of lung cancer this year as died in 1933, according to official reports. Though our research scientists are making every effort to discover the reason for this increase, they still don't know the answer.

They *do* know, however, that the lives of over half of those who will develop lung cancer *can* be saved . . . if they get proper treatment while the disease is still in the silent stage, before any symptoms have appeared.

That is why we urge you to have a chest X-ray every six months when you have your regular health check-up . . . no matter how well you may *feel*. Since only an X-ray can detect the "silent shadow" in its earliest stages, it is your best insurance against death from lung cancer.

For more detailed information about this or any other form of cancer, call our nearest office or simply address your letter to "Cancer" in care of your local Post Office.

American Cancer Society

Three

waste water problems solved by

GRAVER

REACTIVATOR

Here was a particularly difficult problem of high solids in waste water in a large eastern process plant.

This waste water contains up to 1500 ppm of suspended solids and 3000 gpm were to be treated. The problems were:

(1) to prevent stream pollution,

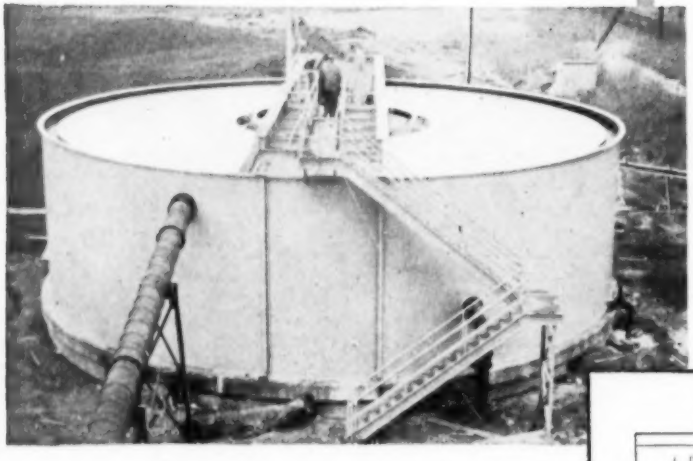
(2) to produce solids of the highest concentration for disposal,

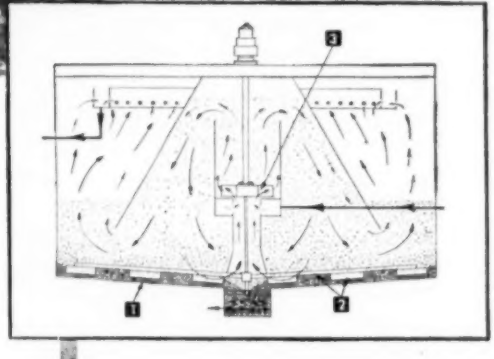
(3) to recover clear water for process use.

A Graver Reactivator was selected to solve this multiple problem. The Reactivator is doing the job so effectively that it delivers solids up to 14% by weight while producing an effluent suitably clear for recycling in the system, *without any chemical treatment.*

In plants all over the country, Graver Reactivators are effectively and economically treating raw water supplies and conditioning waste waters for reuse or for trouble-free disposal. These units can solve *your* liquid conditioning problem, too. Their distinctive design is described in Bulletin WC-103.

Write today for a copy and for free technical paper, "Some Economic Factors in Waste Water Treatment".





Three exclusive Graver Reactivator Features

1. *Full bottom area for solids concentration and collection.*
2. *Separately driven highly efficient sludge scraper and blades.*
3. *Positive and intimate contact of incoming water with sludge by variable speed sludge recirculation impeller.*

GRAVER WATER CONDITIONING CO.

Division of Graver Tank & Mfg. Co., Inc.

DEPT. PP-R, 216 WEST 14th STREET, NEW YORK 11, N. Y.

In Canada: The Bird-Archer Co., Ltd.; Cobourg, Ontario

In Mexico: Proveedores Tecnicos, S.A.; Pueblo 259, Mexico 7, D. F.

GRAVER

GW 458

(*To obtain more data on advertised products see page* 280)

Tenamene 1
Tenamene 2

most effective gum inhibitors known

Tenamene gum inhibitors have set the standards of the industry for over 15 years. No known inhibitors are more effective in preventing gum formation.

They're economical too. For example, as little as 5 pounds of Tenamene 1 may be needed to treat 1000 barrels of gasoline—at a cost of approximately 2½¢ per barrel.

The use of Tenamene 2 results in an extra dividend for refiners. It can be used as a combination sweetening and inhibiting agent to save time, materials and equipment.

Send for the Tenamene booklets listed in the coupon. They contain interesting general information about gum inhibiting and sweetening as well as specific data about the Tenamenes. Our Petroleum Chemicals Laboratory will be glad to make tests and recommendations on any of your inhibiting or sweetening problems.

SALES REPRESENTATIVES: Eastman Chemical Products, Inc., Kingsport, Tennessee; New York—260 Madison Ave.; Framingham, Mass.—7 Hollis St.; Cleveland—Terminal Tower Bldg.; Chicago—360 N. Michigan Ave.; St. Louis—Continental Bldg.; Houston—412 Main St. **WEST COAST: Wilson Meyer Co.,** San Francisco—333 Montgomery St.; Los Angeles—4800 District Blvd.; Portland—520 S. W. Sixth Ave; Seattle—821 Second Ave.

Tenamene EASTMAN GASOLINE ADDITIVES

Eastman
CHEMICAL PRODUCTS, INC.

Eastman Chemical Products, Inc., Chemical Sales Division, Kingsport, Tenn.

Gentlemen: Send me copies of your booklets: "Inhibiting Motor Fuels with the Tenamenes" and "Tenamene 2 Inhibitor Sweetening."

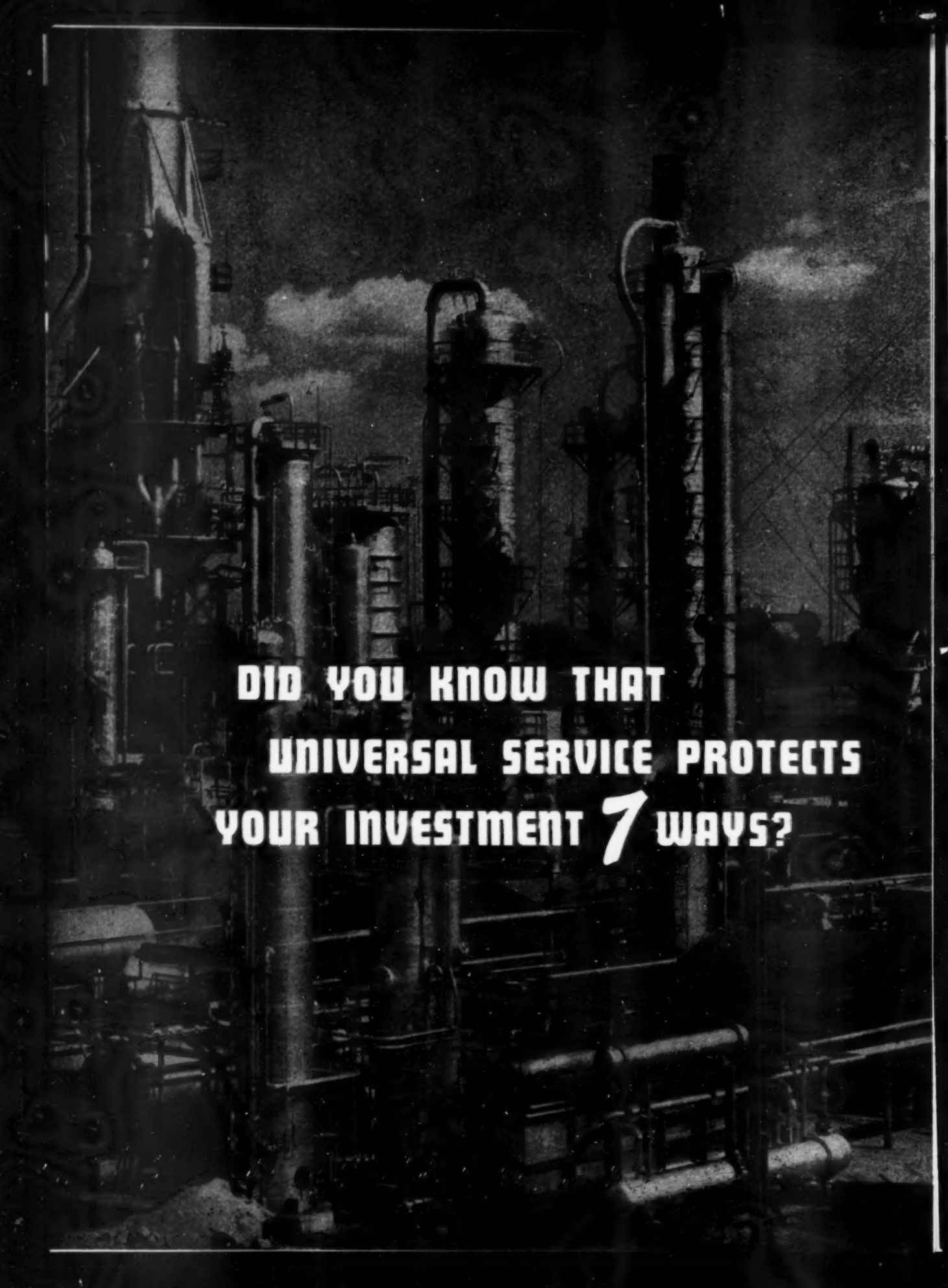
NAME & TITLE .....

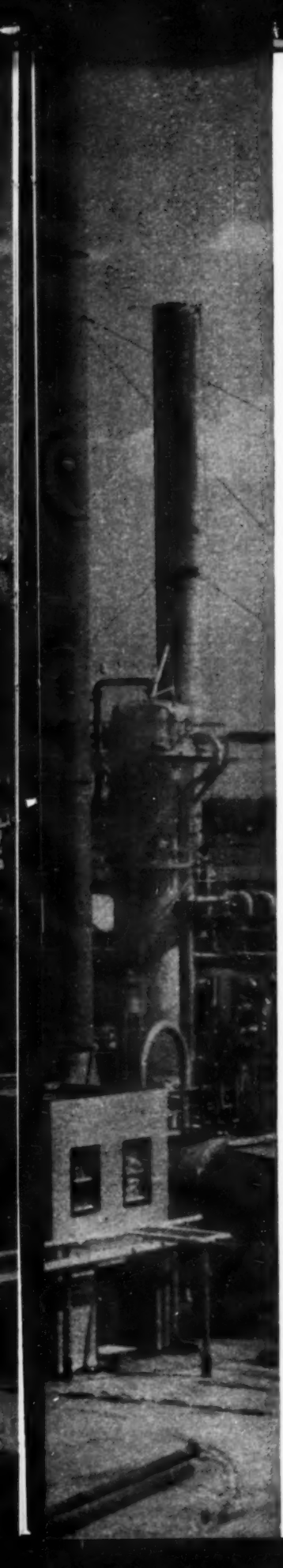
COMPANY .....

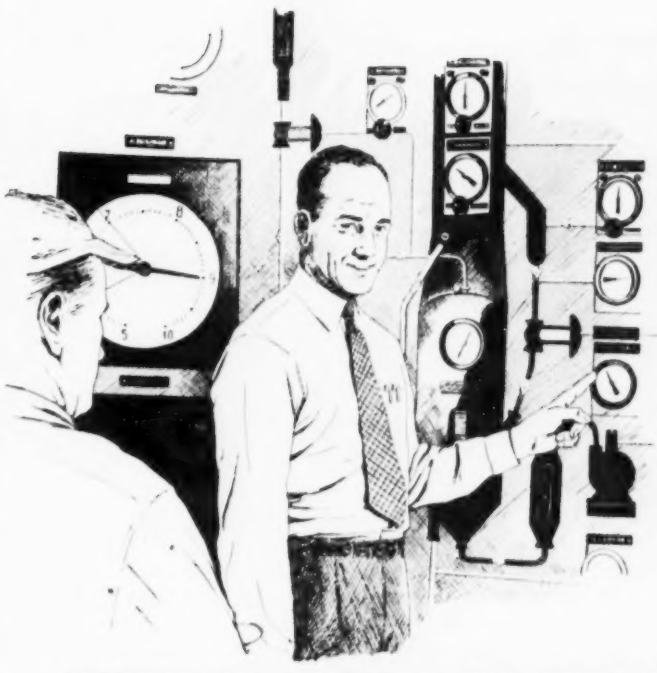
STREET .....

CITY & STATE .....

Sales Representative for **TENNESSEE EASTMAN COMPANY,** Kingsport, Tennessee, division of **EASTMAN KODAK COMPANY.**


DID YOU KNOW THAT
UNIVERSAL SERVICE PROTECTS
YOUR INVESTMENT 7 WAYS?





UNIVERSAL LICENSEE INSTRUCTION PROTECTS YOUR INVESTMENT

Because the efficiency of any refining process is highly dependent upon the knowledge and ability of the operators, Universal has experienced engineers to train refinery operating staffs in the proper operation of processing units.

This instruction is particularly valuable after a new unit is placed on-stream, although it is utilized widely on a continuous basis to keep operators abreast of the most modern methods and techniques, and to assure the refiner of the correct operation and highest efficiency of his processing facilities.

Operator instruction by capable UOP engineers is an important element in the refinery production picture—just another way in which Universal Service Protects Your Investment.

UNIVERSAL OIL PRODUCTS COMPANY

General Offices: 30 ALGONQUIN ROAD, DES PLAINES, ILL., U.S.A.
Laboratories: RIVERSIDE, ILLINOIS

Universal Service Protects Your Investment through laboratory research . . . pilot plant studies . . . design and engineering . . . construction supervision . . . licensee instruction . . . post on-stream service . . . collateral services.

ELIMINATE PITTING AND CORROSION... *Like This!*

It's no secret that one of the biggest headaches of corrosion control in cooling water systems is the continuance of pitting and tuberculation. Many conventional water treatment methods attempt to overcome this problem by the use of excess treatment concentrations. However, this has been found to be expensive and not altogether successful.

But here's welcome news: Betz Laboratories, after long and careful research, has developed the Dianodic Method which positively assures freedom from scale, protection against corrosion and *elimination of pitting and tuberculation!*

Basically, the Dianodic Method consists of employing a combination of two anodic inhibitors in such a way as to produce results superior to any present water treatment. This advanced technique effectively eliminates pitting and tuberculation, and at the same time provides increased protection against general corrosion.

Results are outstanding! A plant employing polyphosphate treatment encountered severe corrosion, tuberculation and plugging of heat exchangers with corrosion products. Tubercles from ½ to 3 inches in length were found throughout the entire system. Often it was necessary to drill some of the heat exchangers at 30 day intervals to remove accumulated corrosion products. Then the Betz Dianodic Method was used. It was necessary to set up a cleaning program after the application of the Dianodic Method to remove the sloughed off corrosion products that accumulated. After three months operation, this cleaning program was discontinued. *No new pitting or tuberculation has occurred!* Heat exchangers are now inspected and cleaned only at the normal annual turn around.

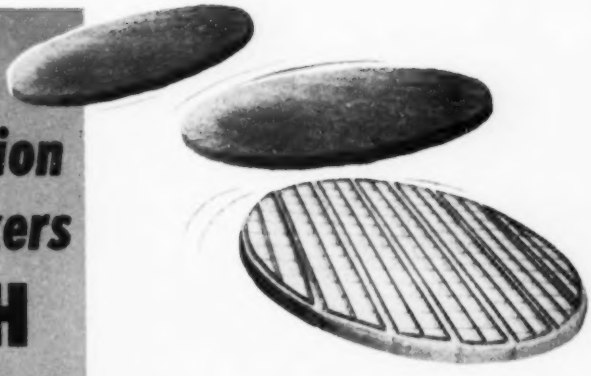
This is just one example of how Betz *Specialized* Water Conditioning Service is increasing efficiency and cutting costs in plants throughout industry. Why not let Betz show you how to improve results at *your* plant? There's no obligation on your part. W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa. In Canada: Betz Laboratories Limited, Montreal 1.

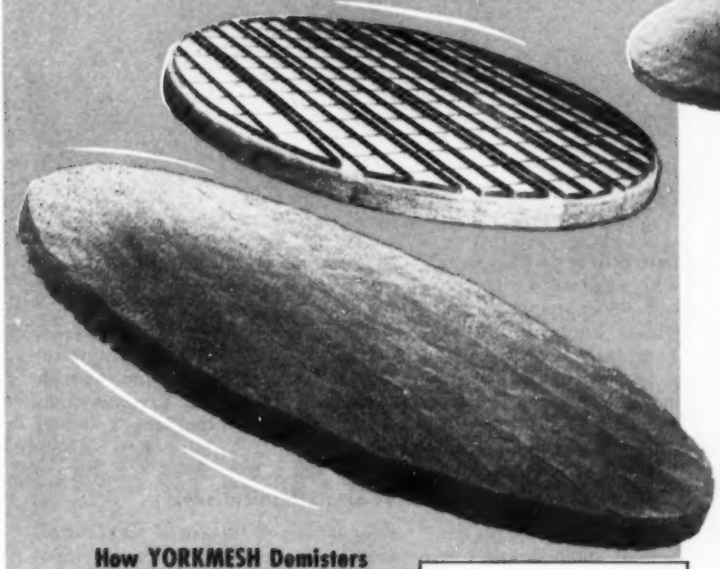
For complete information on the Dianodic Method, send today for Technical Paper No. 123.

BETZ

CONSULTANTS ON ALL WATER PROBLEMS

Reach New Highs in Quality and Production from your Cat Crackers with YORKMESH Demisters...





YORKMESH Demisters are answering Petroleum Engineers demands the world over for simple means of improving the performance and increasing the throughput capacities of catalytic cracking units.

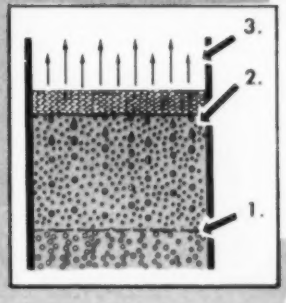
Yorkmesh Demisters in Vacuum Towers remove substantially all liquid entrainment even at increased vapor velocities—the gas oil then produced has lower carbon content and considerably reduced metals content—the reduced metals content accounts for continued high catalyst activity. The net result is more gasoline of higher octane rating.

Yorkmesh Demisters are used equally successfully to improve the performance of gas absorbers, scrubbers, separators, evaporators, knock-out drums, etc.

Easily installed in existing or new equipment.—Materials: Types 430, 304, 316 stainless, monel, carbon steel, etc.—Prompt shipment.

How YORKMESH Demisters work inside Vacuum Towers

1. *Vapor disengaging from liquid creates fine liquid droplets which are carried as entrainment by the vapor stream.*
2. *The liquid droplets impinge on the fine wire surfaces of YORKMESH, and are coalesced into large drops which run down and fall off the YORKMESH.*
3. *The vapor is now dry. It has been entirely freed from entrained liquid. Thus a clean gas-oil goes to the catalytic cracker.*



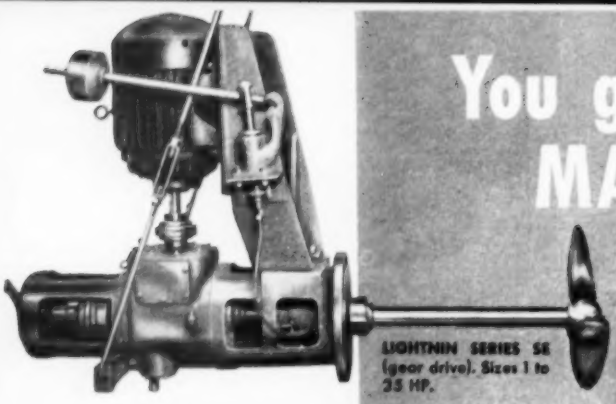
Write for new Catalog 13 for complete information and engineering data on YORKMESH Demisters.

OTTO H. YORK CO., INC.

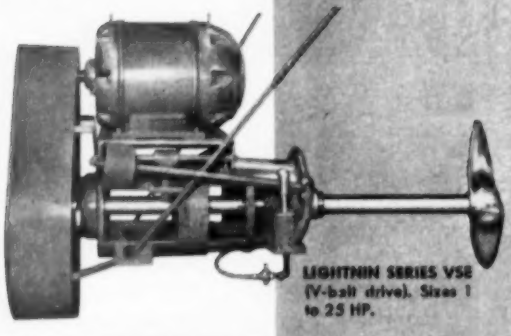
67 Glenwood Place, East Orange, N. J.

You get ROCK-BOTTOM MAINTENANCE COST

with these 2 new side entering mixers



LIGHTNIN SERIES SE (gear drive). Sizes 1 to 25 HP.



LIGHTNIN SERIES VSE (V-belt drive). Sizes 1 to 25 HP.

No wrenches needed to operate new liquid shutoff seal

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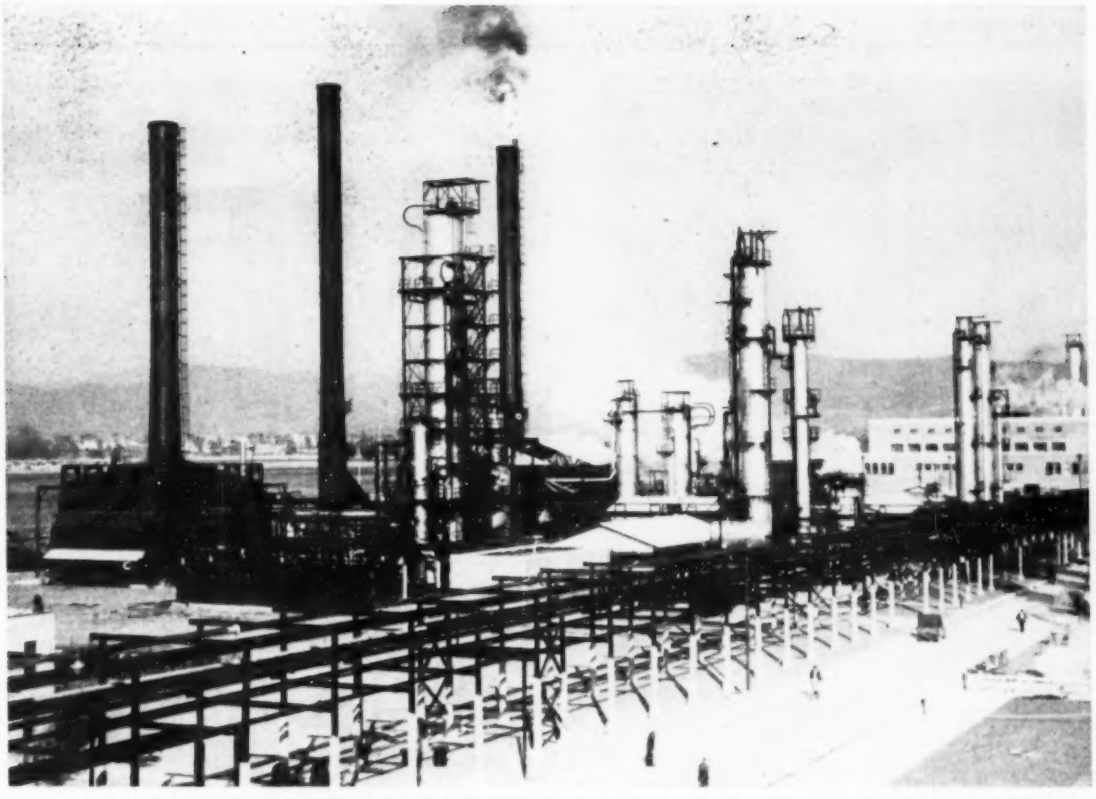


NEATNESS GOES WITH EFFICIENCY in Mexico's refineries, as shown in this general view of the 52,000 b/d Atzcapotzalco refinery, showing (L to R) McKee topping unit, Dubbs cracker, and power plant

Modern Refining in Mexico

Part 1 in a series of exclusive articles describing Mexico's petroleum industry

In typical American fashion much has been said and written of the development and progress in petroleum refining in the U. S. during and since the war years. In contrast, our neighbor to the immediate south has also been expanding and modernizing its petroleum operations in the same period, but in Mexico little has been reported on these developments.

To learn what was going on, Dave Thornton, Southwestern Editor of PETROLEUM PROCESSING, by special arrangement with the Mexican authorities, spent seven weeks in that country visiting the plants there and studying their operations. He brought back with him not only material for five articles, of which this is the first, but also a large number of photographs of Mexican installations, many of them for the first time released for publication. His articles and illustrations will describe the modern plants and operations at Atzcapotzalco (Mexico City), Reynosa, Salamanca, Poza Rica and elsewhere, and tell of other features of Mexico's petroleum refining industry.

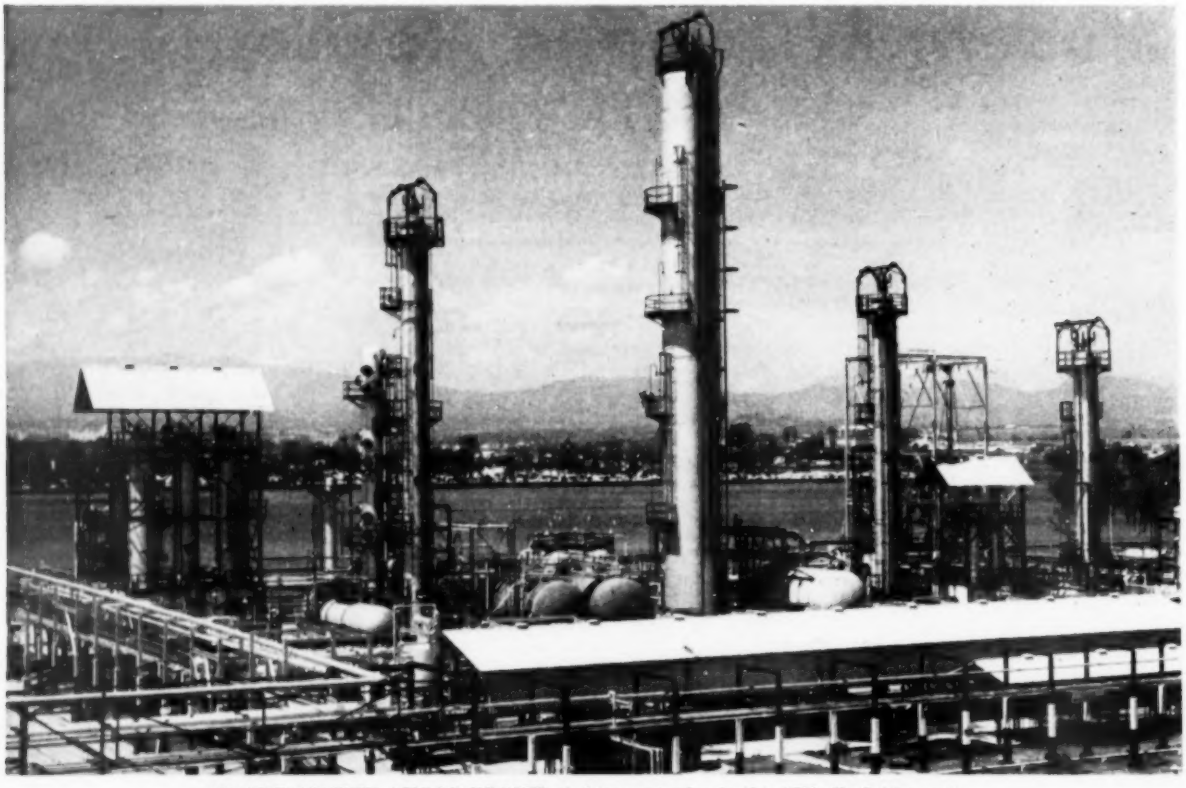
By D. P. THORNTON, Jr.
Southwestern Editor

THE petroleum industry in Mexico has changed greatly in the past 15 years, since the organization of the government-owned, all-inclusive Petroleos Mexicanos (Pemex.) The growth has been most rapid in the past eight years, a logical accompaniment of the industrial revolution taking place. In 1938 the country used refined products in the amount of slightly over 56,000 barrels a day. In 1951 consumption was nearly triple, 161,261 barrels daily. The figures themselves are not impressive compared with U. S. data, but the rate of growth in petroleum utilization in Mexico is striking.

There is visual evidence of petroleum's progress south of our borders, even to the casual tourist, in the Pemex refinery at Atzcapotzalco, which

SOUTH OF THE BORDER, the first refinery is this 4000 b/d Reynosa plant, with a single topping unit

HYDROCARBON SEPARATION towers and Perco treating unit (foreground) at Atzcapotzalco



HEART OF THE AVGAS PLANT at Atzcapotzalco is this HF alkylation unit

is a show place of this suburb of Mexico City. The plant has been expanded and modernized and produces aviation gasoline, along with other products. The visitor who knows something of petroleum refineries in the U. S. is impressed by the neat and orderly operations and technological progress here, at Reynosa and Salamanca, as ell as in the field installations at Poza Rica. Accompanying photographs vouch for the good housekeeping features better than words can tell.

Investments in plants and equipment in Mexico's petroleum industry have increased comparably with growth in product consumption. The Republic of Mexico received approximately 53 million pesos in revenues from oil in 1937-38. In 1951, however, 504 million pesos ($58,265,894 U. S. at the rate of 8.65 pesos per $1) were received under the same tax structure.(1) Even though exchange rates have changed, the latter is a vastly greater figure. At the same time the single oil company, Petroleos Mexicanos, retained 1.6 billion pesos ($184,971,098 U. S.) as net income.(2) From 1947 to November, 1952, the company has spent about $269 million on new installations and for taxes.(3)

What has happened in the petroleum refining industry in Mexico to triple in 14 years the volume of products made? What kind of refineries exist today? What products are made? What processes are used and what quality products made? What is planned for the future?

To answer these questions with first-hand information the writer recently completed a two-months personal investigation of Mexico's refineries, with the cordial cooperation of Pemex officials and local refinery staffs. The conclusion is that the oil industry of Mexico has made great progress and will so continue except for some unusual occurrences. Doubtless it will continue to do much for the country's economy.

An industrial "revolution" is well under way in Mexico, bringing with it increased national dependence on oil products for power and transportation. The future is bright, providing oil production and reserves prove adequate.

Just to illustrate the change, eight years ago even in Mexico City it was next to impossible to buy premium gasoline. Service stations were scarce; supplies undependable. Some hotels kept private supplies for guests. It was not unusual for the motorist needing gasoline to park his car on known truck routes, watch for a transport and follow it to its destination in order to get in line for—usually—20 liters (a little over 5 gal.). The "stalking" procedure was repeated until fill-up was accomplished. Naturally there was little inter-city "Sunday driving;" besides, highways were not good. Aviation gasoline was imported.

Today, except in the northwest (desert) areas and parts of the Pacific Coast, away from major highways, motorists need not carry "gas". With reasonable care there now is little danger of "running dry." Main highways are excellent and there is much inter-city traffic and pleasure driving. In 4100 miles the author had no difficulty securing a "fill-up" at every stop and no complaint about fuel performance in a 1950 Ford V-8.

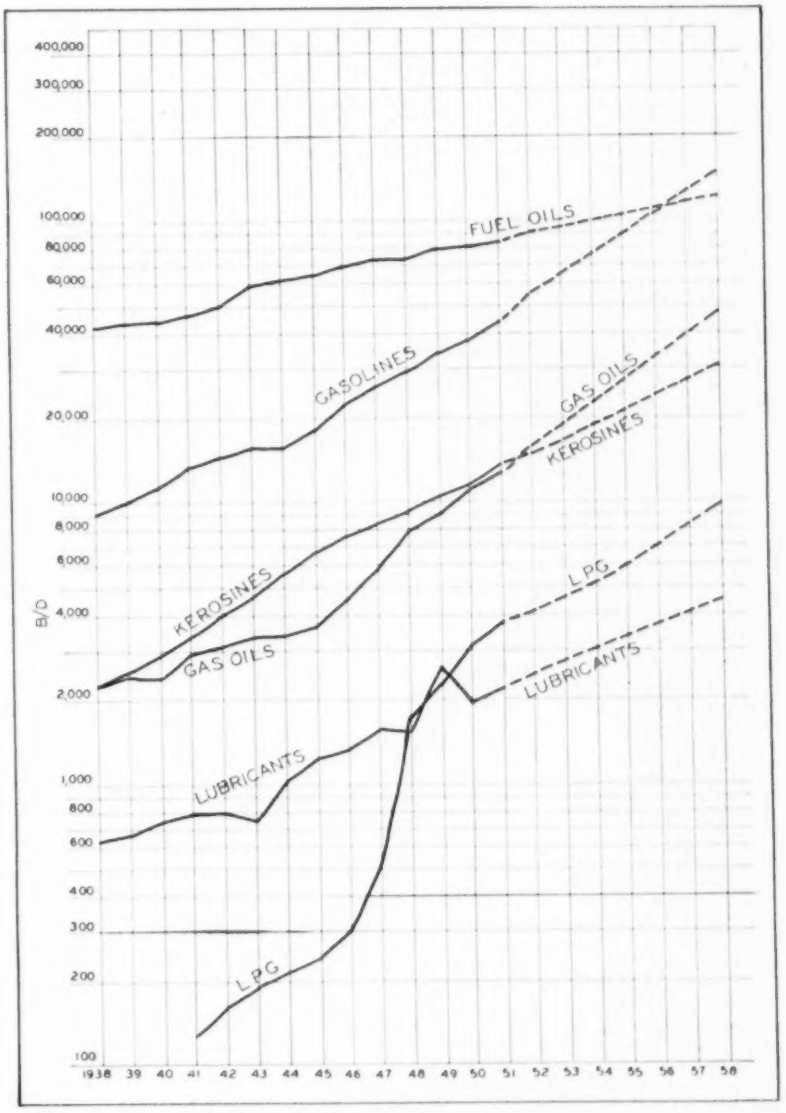


FIG. 1—Consumption of Oil in Mexico is climbing. Shown on this chart are consumption figures for the six principal petroleum products from 1938 through 1951, with anticipated requirements to 1959

Fig. 1 shows the consumption of Mexican refined products from 1938 through 1951, the latest data available, covering the six principal products. Growth for the most part has been steady except for the skyrocketing increase in butane (liquefied gas) since 1946.

The extrapolations on the chart for future consumption are believed valid since they reflect anticipated increases in productive capacity and consumption of most products now is largely restricted by availability. It will be noted that, with the exception of fuel oils, consumption of refined products is expected to at least double while gasoline and gas oils

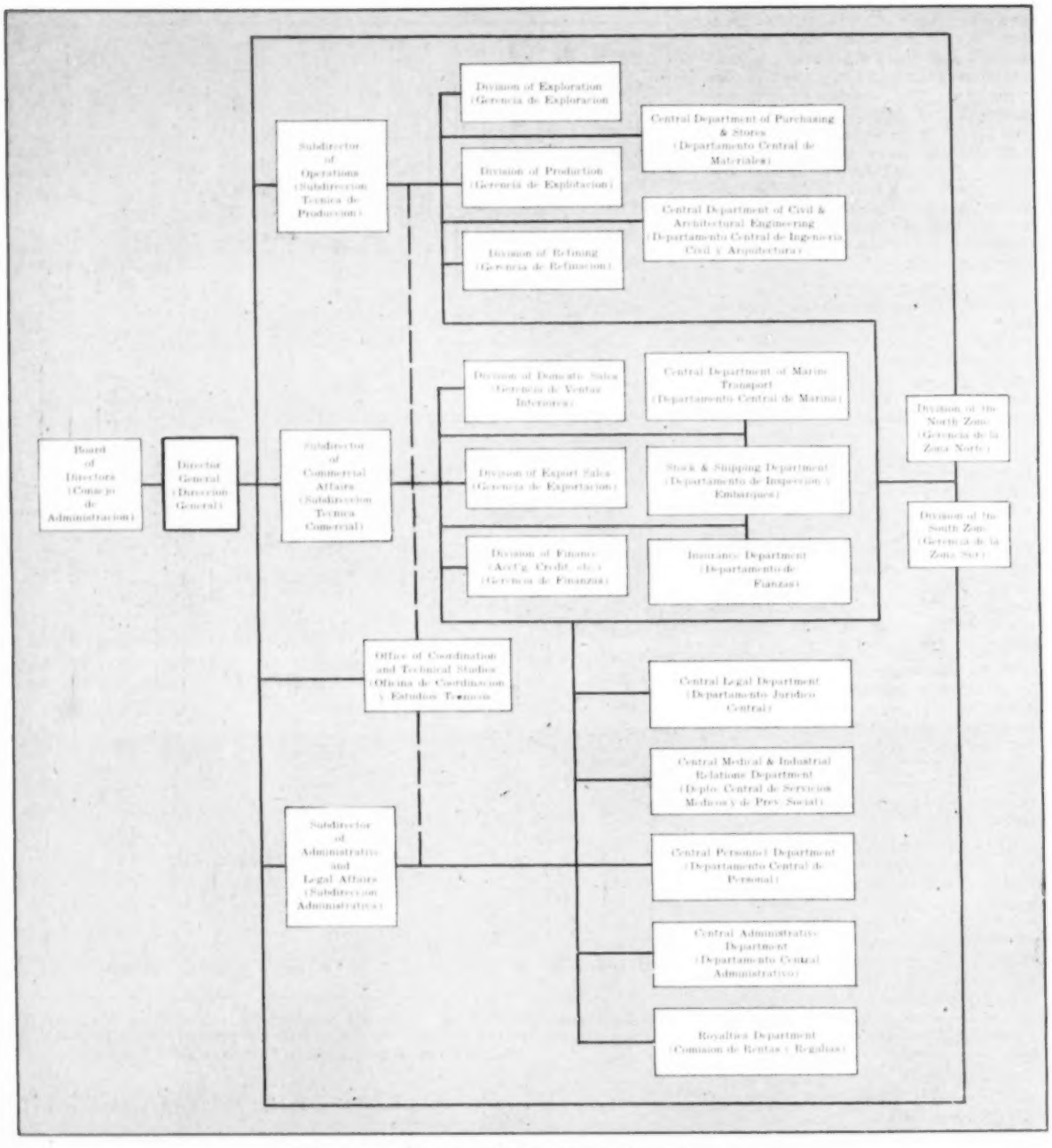

Board of Directors (Consejo de Administracion)
Director General (Direccion General)
Subdirector of Operations (Subdireccion Tecnica de Producccion)
Subdirector of Commercial Affairs (Subdireccion Tecnica Comercial)
Subdirector of Administrative and Legal Affairs (Subdireccion Administrativa)
Office of Coordination and Technical Studies (Oficina de Coordinacion y Estudios Tecnicos)
Division of Exploration (Gerencia de Exploracion)
Division of Production (Gerencia de Explotacion)
Division of Refining (Gerencia de Refinacion)
Division of Domestic Sales (Gerencia de Ventas Interiores)
Division of Export Sales (Gerencia de Exportacion)
Division of Finance (Acct'g, Credit, etc.) (Gerencia de Finanzas)
Central Department of Purchasing & Stores (Departamento Central de Materiales)
Central Department of Civil & Architectural Engineering (Departamento Central de Ingenieria Civil y Arquitectura)
Central Department of Marine Transport (Departamento Central de Marina)
Stock & Shipping Department (Departamento de Inspeccion y Embarques)
Insurance Department (Departamento de Fianzas)
Central Legal Department (Departamento Juridico Central)
Central Medical & Industrial Relations Department (Depto. Central de Servicios Medicos y de Prev. Social)
Central Personnel Department (Departamento Central de Personal)
Central Administrative Department (Departamento Central Administrativo)
Royalties Department (Comision de Rentas y Regalias)
Division of the North Zone (Gerencia de la Zona Norte)
Division of the South Zone (Gerencia de la Zona Sur)

FIG. 2—General Organization of Petroleos Mexicanos

will triple 1951 figures. There are two things which will keep demand up for heavy fuel and at the same time account for the increased use of gas oils. At present railroads are the principal heavy fuel consumers but are converting to diesel equipment. Railroad expansions will absorb the gas oils and continue to use much heavy fuel as ton-mileage steps up while industrialization will take care of any "excess" quantities of either as they become available. Gasoline usage will be accounted for by more trucks and cars plus increased use of aircraft.

The continued expanding use of butane and future inclusion of propane in liquefied petroleum gas is anticipated for home cooking as well as industrial use, where it can be afforded. The government already has placed domestic use of wood and charcoal as fuels under constantly tightening restrictions. This is reflected in kerosine and liquid gas consumption. Increasing use of tractors in agriculture will absorb much of the increased kerosine production.

The oil industry of Mexico should not be compared with that of the U. S. however, despite many past attempts to do so. There is no valid common yardstick. It is true that the Mexican methods of producing

oil and their processing techniques, as well as the modes of distribution, in general have been derived largely from U. S. technology, but there remain great differences. These contrasts can be reconciled only because of the coexisting differing requirements imposed by the economy, sociology and geography of the respective countries.

This and other articles to follow will describe the refineries, processes and products made from oil in Mexico as they are today, first giving the basic background and then discussing the several principal refineries and products made. Particular effort has been taken to avoid tedious description of well-known processes and operations; rather, emphasis is given to the "unusual," whether product, product quality or process.

Organization of Pemex

One cannot write of the petroleum industry in Mexico today without telling about Pemex. As is well-known, Petroleos Mexicanos, (Pemex for short), is a government-owned company and constitutes Mexico's entire oil industry. It is generally considered in the U. S. to be closely controlled by the Mexican government and therefore its actions those of an official government agency. While it is a "monopoly" by U. S. standards, Mexicans look upon its operations in an entirely different manner —much, in fact, as we view the operations of a public utility. Actually, this is not entirely correct, as it is simultaneously a government service agency and a private industry.

Pemex is organized similarly to a private U. S. business, much as though the several foreign-owned oil companies which did business in Mexico until 1938 had merged into one. There is no corporate stock or individual owners, however. Pemex is specifically charged under provisions of Mexican law to explore for, produce, refine and distribute (sell) crude oil, gaseous hydrocarbons and refined products of all kinds made from them. (In Mexico, as in many other countries, all minerals belong solely to the Nation. A landowner has title only to the surface rights.) In this respect Pemex is a government agency.

But Pemex is not a government agency in the sense that its employes are public servants; they are not. Their conditions of employment and dismissal are governed by the same laws applicable to all private industry. Pemex submits reports to its owner, the government, exactly as any private company reports to its stockholders and currently it is Mexico's largest taxpayer.

Pemex has taken the motto: "Al Servicio de la Patria." Literally translated, this is both a key to ownership and a blueprint of operations: "To the Service of the Country." National needs always are paramount, to the end that petroleum and its products must be supplied when and where needed, regardless of costs, profits and inconvenience to the company. In addition, there is another major duty which no U. S. oil company ever has been asked directly by government to assume: Pemex must assist in raising the national standard of living by every reasonable means. In consequence it has gone far in purely social responsibilities both to its own employes and the public.

Ownership and Control

As in any company, Pemex stockholders elect the board of directors—Consejo de Administracion in this case—and through them indirectly control company operations. Six men comprise the directorate: four government ministers and two special advisors on finance and economics. But even here there is an unusual difference, since there also are four other advisors to the Consejo selected by the union which represents a majority of Pemex's employes. This is the "Sindicato de Trabajadores Petroleros de la Republica Mexicana" ("Union of Oil Workers of the Republic of Mexico"), popularly called "the sindicato" (in English, syndicate). There are sindicatos in most branches of industry, as with U. S. unions.

The directors include: the Secretary of National Economy (Secretario de la Economia Nacionel), chairman of the board; Secretary of Finance (Secretario de Hacienda y Credito Publico); Secretary of Foreign Affairs (Secretario de Relaciones Exteriores); Secretary of Public Administration (Secretario de Bienes Nacionales e Inspeccion Administrativa), and the two finance and economic advisors. These, plus a Director General all are appointed by the President of Mexico. Each has a six-year term coinciding with that of the President.

From here on Pemex is organized like a private company, the Director General being analogous to president. With the advice of the directorate three subdirectors, also serving six-year terms, are chosen by the director; they rank equivalent to vice-presidents in U. S. companies. Below this level personnel are not affected by governmental changes.

The remaining point of government control is that all prices charged are fixed at both wholesale and retail levels by the Secretary of National Economy. In this Pemex is in no unique position, however, for the prices charged by many other entirely privately-owned businesses are similarly controlled in Mexico, particularly such as hotels and public transportation which the tourist is likely to encounter. Moreover, in the U. S. we had the Office of Price Administration fixing prices from soup to nuts during World War II and the Office of Price Stabilization now exercises similar control over private industry.

Three Major Divisions

Petroleos Mexicanos is split into three major divisions, each under a sub-director, as shown in the organization chart, Fig. 2, which deal respectively with operations, marketing and administration. Operations, under which comes refining among other things, will be discussed in more detail subsequently.

Marketing will be noted as split into the major divisions of domestic and export sales, and not only encompasses sales but operations of distribution terminals (bulk plants) as well as marine transportation of crude and products, whether for domestic or export destinations. In this connection, to supply the country's west coast it has been necessary to move products out of one or more ports in Veracruz state through the Panama Canal until only recently. Now the 156-mile, 10-in. pipe line from Minatitlan on the east coast of the Isthmus of Tehuantepec to Salina Cruz on the west coast has been completed. Presently it is carrying some 15,000 b/d of refined products. Ultimately this line is destined to carry up to 30,000 b/d of crude supplies to refineries as yet unbuilt.

The administrative division combines the functions of legal, personnel and industrial relations. Its various departments perform job studies, handle personnel records and such problems as pay rates, medical and social services, job classifications, long-range personnel planning, employe transfers and the like. It is here that many of the company's social services, job tenure, employe security and other programs are developed, including efforts to raise the standards of living of its employes as well as all of Mexico.

Operating Division

The operating division, as shown in Fig. 2, is logically split into the three principal classifications of exploration, production and refining. There are two other groups, however, which are somewhat unusual. One is the department of civil and architectural engineering, which has under its jurisdiction standardizing the civil engineering work connected with production, refining, distribution and social services projects. The architectural side is most important because Pemex owns and builds schools, employe housing, hospitals

MODERN HOSPITALS such as this one at Poza Rica are furnished by Pemex for employes and their families where local conditions are not adequate

MODERN ARCHITECTURE characterizes this entrance to the Salamanca refinery. Guard's office is at left, personnel office at right

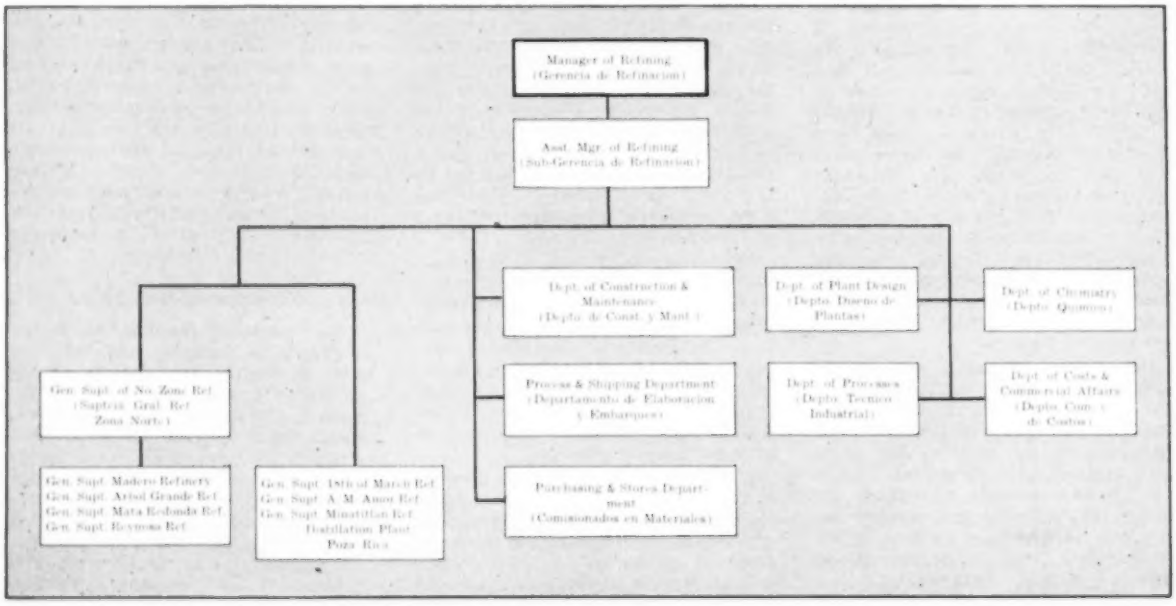

Manager of Refining
(Gerencia de Refinacion)
Asst. Mgr. of Refining
(Sub-Gerencia de Refinacion)
Dept. of Construction & Maintenance
(Depto. de Const. y Mant.)
Dept. of Plant Design
(Depto. Diseno de Plantas)
Dept. of Chemistry
(Depto. Quimico)
Process & Shipping Department
(Departamento de Elaboracion y Embarques)
Dept. of Processes
(Depto. Tecnico Industrial)
Dept. of Costs & Commercial Affairs
(Depto. Com. y de Costos)
Gen. Supt. of No. Zone Ref.
(Superin. Gral. Ref. Zona Norte)
Gen. Supt. Madero Refinery
Gen. Supt. Arbol Grande Ref.
Gen. Supt. Mata Redonda Ref.
Gen. Supt. Reynosa Ref.
Gen. Supt. Ref. of Marsh Ref.
Gen. Supt. A. M. Amor Ref.
Gen. Supt. Minatitlan Ref.
Distillation Plant
Poza Rica
Purchasing & Stores Department
(Comisionados en Materiales)

FIG. 3—Refining Department organizational chart

and industrial buildings of all kinds, and such work is coordinated by this department.

Due to the fact that the three principal jobs of this division all cost money and make great demands on the company's capital, and because a separate division of equal rank "makes" all the money, the "Office of Coordination and Technical Studies" has been created as a staff, rather than a line, organization. Its duties are to coordinate the desires and needs of the three line organizations in line with policy decisions and recommend accordingly through the subdirector. It makes technical studies of operations, considers new processes and developments, et cetera, from a detached, unbiased, overall standpoint.

There are a number of sub-sections pertinent to the various phases of its work. Under many different names and positions in the organization chart its counterpart can be found in many U. S. companies. The office also handles much of the contract-work in this country betwen Pemex and suppliers of equipment, process licensors and engineering contractors.

Fig. 3 shows the detailed organization chart for the refining department, of the operating division of Pemex, headed by a manager and an assistant manager. This is divided into two major groups of operating and staff. All of the refineries are not under the same general supervision, it will be noted, since superintendents at the Atzcapotzalco, Salamanca, Minatitlan refineries and Poza Rica distillation plant report to the general management, while those in the North (and Northeast) Zones are under a single overall general superintendent.

The staff departments, which are located in the general offices in downtown Mexico City along with the manager, for the most part have their counterparts in the individual refinery organization charts. Policies and procedures for the individual refinery departments are in general set by the staff department decisions.

Pay Rates

The wage scale of Petroleos Mexicanos is not the highest in Mexico, although it once was and, relatively unchanged, it has waited for other industry to "catch up." Actual pay scales are omitted herein as meaningless without careful, detailed comparisons with other industries.

But a fair wage scale is not the only thing its employes enjoy, for outstanding social benefits make resignations and "job shifting" uncommon. Workers also have the protection of Mexican labor law which provides, among other things, that three months' notice (or pay in lieu of notice) must be given any "permanent" employe in event of dismissal.

Pemex provides medical care for all its employes (including any medication, dental care and surgery) which also extends to members of his family residing with him; company hospitals are provided where local facilities are inadequate. Schools are provided in remote locations and in refinery and oil-field camps excellent recreational facilities are to be had. In some cities where the public water supply is poor Pemex either has or is arranging to supply the public with free potable water.

Ten percent is withheld from each employe's regular pay-check. This is made available to him along with a 20% bonus each year just before Christmas. Permanent employes with less than 10 years' service receive 21 working days vacation at double pay; those with over 10 years get 30 working days. All over-time work and "hazardous" classifications are at double pay.

All workers in other than the main offices receive a monthly allowance to help defray housing costs. If their duties do not involve the assignment of a car or truck, employes either receive an allowance of gasoline or the equivalent in free bus tickets. Supervisory employes in refineries or field camps are furnished housing, a maid and all utilities.

A great effort is being made in connection with increasing national living standards to stress "good housekeeping" at all installations. This is especially evident in the newer refineries, where equipment is in excellent shape. It is also apparent in the attitude of the workmen, who for the most part are excellent craftsmen. Each man is obviously proud of his unit, pumps, or other equipment and sees to it they are taken care of.

Retirement is permitted at age of 55. If the employe then has accumulated 25 years of service, his retirement pay is 70% of his last annual pay for life. If 30 years of service has been achieved, the employe retires on 80% of his pay.

Pemex thus is a substantial example in creating Mexico's new middle class.

Mexico's Oil Problems

Mexico's oil industry like ours, has its problems. Some are based on worldwide conditions; others are peculiarly domestic. The operations of Petroleos Mexicanos will appear alien and, to some extent, "behind the times," unless they are judged with these problems ever in mind.

It is beyond the scope of these articles to argue the rights or wrongs of nationalizing an industry. Judgment is not rendered as to whether the job of providing for Mexico's oil needs has been well done or might have been done better by private enterprise. The reader should form his own opinion from, we hope, a factual picture of refining operations as they are and the reporting of Pemex's own explanation of the reasons. In this connection, Pemex simply carries out the job assigned it, an enormous responsibility created 15 years ago by the nationalization act.

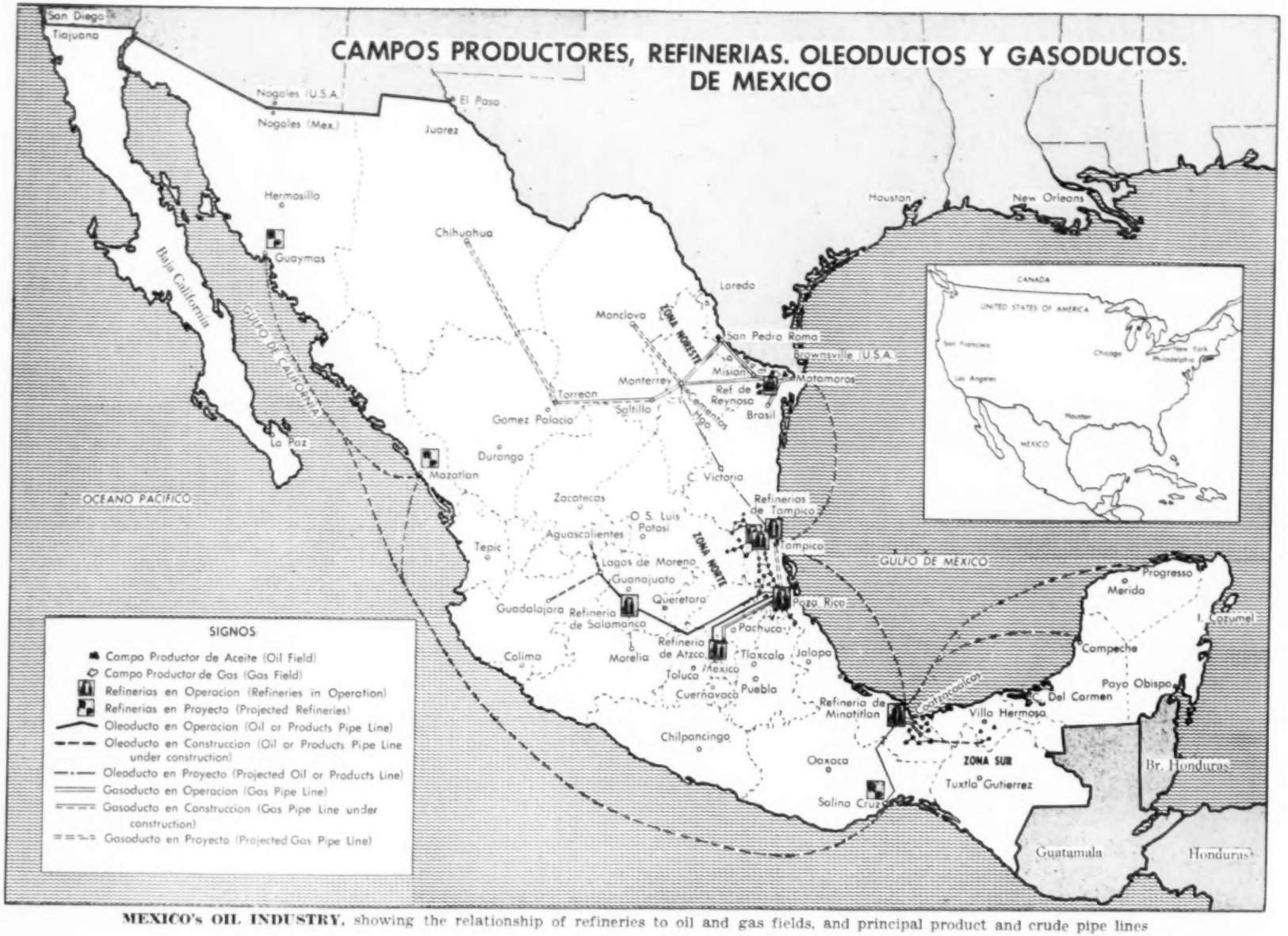
A most important factor affecting Pemex aside from its industrial relations obligations is the rapidly growing industrialization of Mexico. Many natural resources are said to be relatively untouched and there is much to be developed in the way of manufacturing operations of all kinds. Already the country is in the throes of mechanization, in sharp contrast to the high predominance of handicrafts. But, to have this, both power and fuels are needed.

Unfortunately, Mexico has but small known reserves of coal. Most of it is used for metallurgical purposes. The only other known important sources of fuel and power are from petroleum hydrocarbons and hydroelectric installations. Much is being done and is in prospect for electric power, which still is woefully short of potential demand. The forests are dwindling—a devastation which started with Cortez in the 16th Century—and, although reforestation projects are under way, the use of wood as fuel is officially discouraged for this reason.

Moreover, neither industry nor the nation's 25,000,000 population is evenly distributed. Mexico is a scenic land between two tremendous mountain ranges which slope abruptly to the coasts and enclose between them a vast central plateau averaging 5000 ft. and more above sea-level. The climate is variable but predominantly cool because of altitude rather than tropic location. Most of the people live on the high plateaus, while major industrialization is centered around Monterrey and Mexico City.

Geography Affects Distribution

One chief problem of the Mexican petroleum industry is the difficulty of distribution of products. This is affected by the geography, the altitudes occupied by the bulk of the population, and the relative inadequacy of rail transportation. Only within the past few years has the present highway system developed. To these couple the fact that, before 1938, five of the total of six refineries were located close to the oil fields and convenient to ocean transport; intended primarily to serve export requirements rather than the economy of a nation which was not



MEXICO's OIL INDUSTRY, showing the relationship of refineries to oil and gas fields, and principal product and crude pipe lines

then in position to utilize oil products. Indeed, four refineries were located in the environs of Tampico and the remaining two were small.

This explains why, for example, the FOB refinery price for stove oil (kerosine) at the Atzcapotzalco refinery (Mexico City) is only 6.1c (U.S.) a gal., including taxes, while the retail price is 6.6c. If the poor are eventually to be prohibited from using wood they must have a fuel they can afford to use, and similarly stoves priced below the cost of manufacture in which to burn it. It also explains why crude and products are piped over mountains, and products made available in relatively inaccessible areas, regardless of the fact that many other areas are much more attractive profitwise, while still other products might offer a greater monetary profit.

Pemex owns most of the bulk stations in the country, excepting a few handling fuel oils, the principal reason being to assure proper distribution to service stations and consumers wherever located. There is good reason behind the following conditions.

Why the distribution of products by truck is so large as compared to the movement by pipeline;

Why areas served by the various refineries are elastic;

Why more oil products are not used;

Why just recently have product pipe lines existed, and

Why relatively small, new refineries are planned while existing, larger ones need modernization.

Quality of Gasolines

The high altitude prevailing over much of Mexico's heavily populated areas is the main reason why gasolines—"money crop" as in the U. S. —at first glance are sub-standard by U. S. specifications (excepting aviation gasolines). Only 10% of the automotive gasoline in Mexico meets requirements for premium grade "Super Mexolina," testing 80 oct. Motor Method with 3 cc. TEL, whereas the regular grade Mexolina, must test 70 oct. but specifications otherwise are identical. A third grade testing 60 oct. is made principally for trucks and buses and sold in bulk quantities.

The two automotive fuels may not necessarily be alike in hydrocarbon make-up, due to varying contents of cracked and catalytically desulfurized components. There are as yet no catalytic cracking and polymerization units installed in Mexican refineries.

The Research octane rating is not used. Mexicans feel there is no advantage at present in switching to it for two main reasons. First, the Motor method gives sufficient data for refinery control purposes. Second, from the advertising standpoint there is nothing to be gained because there is only one oil company; technical differences between the methods would mean little to the public.

In the coastal lowlands 80 oct. premium is needed by the average auto with spark settings as generally used over most of the U. S. These areas are not heavily populated, although there are a few large cities and the first 400-odd miles of the Laredo, Texas-to-Mexico City highway is below 2000 ft.

The balance of the consuming areas average 5000 ft. and more above sea-level. Mexico City and environs, the heaviest populated and most industrialized area, is 7400 ft. and is reached through passes at elevations ranging from 8300 to over 10,000 ft., depending on the route chosen.

At these altitudes the octane requirement drops sharply and 70 oct. (M) gasoline is adequate for most engines. High compression engines, when properly adjusted, rarely have difficulty with 80 oct. (M) gasoline in Mexico City. The altitude there, in effect, is the equivalent of seven or more octane numbers.

The loss of power evident in the engine is not attributable to the gasoline, incidentally, but rather to the reduced amount (pounds) of air available per pound of fuel. This loss can be avoided only by supercharging the engine to provide the sea-level pressure for which it was designed. The power loss generally is at least 30% in the well-adjusted engine. Stalls can be eliminated by adjusting to a richer mixture under penalty of reduced fuel economy. With sensible driving habits most cars do not need this carburetor adjustment.

Future Plans

However, Pemex does worry about the "octane race" because most of Mexico's automobiles and trucks come from the U. S., assembled or knocked down; only a few are European. Consequently, catalytic cracking facilities are planned for at least two refineries in the near future; and more probably will come.

There likely will be very few aromatization units installed in Mexican refineries because there is only limited production of a single crude —Panuco—which contains sufficient cyclic hydrocarbons to justify them. It is quite possible, however, that the future will see at least one installation. Its production will not be used primarily for fuel, but to provide benzene for chemical and solvent purposes. Catalytic reforming likely will increase.

But octane numbers are not Pemex's only, or biggest, problem. The big problem is this, in a nutshell:

Its rated refinery throughput is 236,000 BPCD, of which 150,000 b/d is located at or near sea-level in so-called "coastal areas," and the remaining 86,000 b/d in the interior. *But,* while only 36% of refining capacity is located in the high central plateaus, here more than 75% of the actual demand is concentrated. Known crude production also is along the coasts.

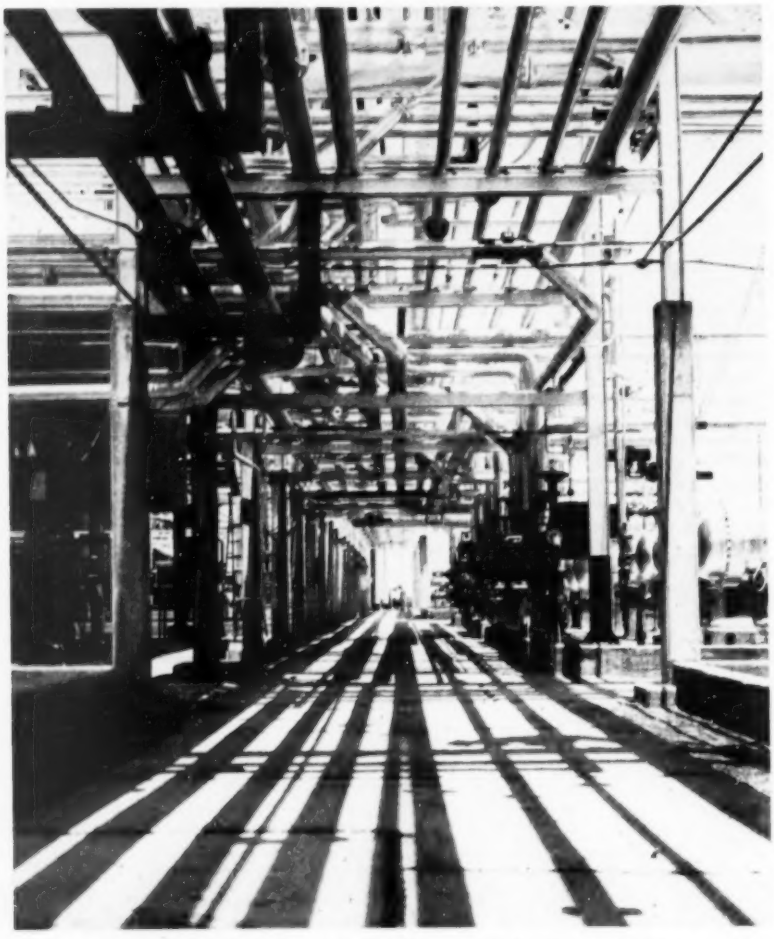
Add to this the previously described deficiencies in transportation to move products to market and the country's geography. This leads to the obvious conclusion that existing refinery capacity is disadvantageously located with respect to demand and that either crude must move to refineries more advantageously located, or the products must be transported. The latter alternative is not the best because fuel oil of the Bunker "C" variety, much used by inland industry, cannot be economically moved by pipe line. So it is that a dearth of heavy fuel now exists inland while the tanks of coastal refineries are running over.

Couple to this another headache. There have been but few new crude fields uncovered in Mexico in the past 14 years. This is really two problems because crude is not only needed for domestic consumption but for export as a ready source of dollar exchange; Mexico is not yet a wealthy nation, though its people may make it so.

Only recently, The Ezequiel Ordonez field has been discovered near Poza Rica. Its potential at present is believed in excess of 50,000 b/d. Seven wells have been drilled and more will be completed as soon as possible. One of the early wells produced 6000 b/d through a 20 mm. choke (about ¾ in.). A line has been completed into Poza Rica and latest reports say 10,000 b/d of this heavy, mixed paraffinic-asphaltic base crude are being delivered with only two wells on the line; the remainder will be connected as soon as gas separating equipment can be installed.

Thus Mexico has faced three major problems in its oil industry. The first is a need for relocating, modernizing and expanding refining capacity; the second, to find more crude oil. Number three is more and better transportation facilities. Pemex has concentrated most on more oil production while doing as much as possible on the other two. There are high hopes that the new field, so conveniently located that its crude reached refineries and was ready for export within three months of discovery, will justify shifting some of the emphasis elsewhere.

This triad explains why new refin-



GOOD HOUSEKEEPING is typical of the new refineries in Mexico, as indicated by this operating aisle at Atzcapotzalco

eries have been built while old ones have not been modernized and a little, old plant in Mexico City now is one of the major installations. This is why a pipe line across the Isthmus region is operating and three new plants are scheduled for the Pacific Coast, where there is no known oil production. But these are just a few of the things which have been done.

The locations of the principal oil fields of Mexico and relationship to its refineries are shown on the map accompanying this article. It will be readily seen that there are three principal oil-producing regions along the East coast. Crude oil and gas pipe lines also are indicated. The dotted lines offshore show the direction of tanker and barge movement of crude as well as products. Included also are confirmed present plans for future expansion and some of the work currently underway.

It already is evident that the completed work is not enough. The refineries at Atzcapotzalco and Salamanca are slated for further expansion because their combined capacities already are inadequate to supply pent-up demand in the central area. Rail facilities, although being constantly improved and modernized, still are overburdened and it continues to be necessary to shift the extra demand load to whatever refinery has a "temporary surplus" of products, moving them by truck over the steep mountains.

More new refineries are needed, as well as expansions of existing ones; also more pipe lines to move crude, gas and products. Some of this is underway.

The lubricating oil and wax production facilities of Mexico, currently at Minatitlan and Tampico, respectively, are insufficient to meet current demand. Consequently, some $6 million worth of base stocks are imported annually, largely from the U. S., for compounding in one of the Tampico refineries. Further quantities of branded U. S. oils are sold privately (not by Pemex, however).

To make Mexico self-sufficient on lubricating oil and wax, and in lieu of modernizing the lube plant at Minatitlan in the immediate future, a large and highly-flexible ultra-modern lube plant was commenced late last summer at Salamanca. When completed in 1954 this will provide adequate quantities of high quality oils with or without continued production at Minatitlan. Wax will supplement that produced at Tampico, which last will not be greatly changed.

Solution to one of the remaining problems, the modernization of existing refineries, is planned for the near future. The only reason that these plants have been seemingly neglected is that heretofore there have been more pressing problems and because the coastal areas served are neither densely populated nor heavily industrialized. Besides, there was not enough money to go 'round. Hence the old plants have had enough attention to keep them going but otherwise left to take care of themselves.

The map of Mexico indicates a products line is planned to supply Monterrey via C. Victoria from Tampico, possibly Saltillo later. A products line has just been completed as far as Lagos de Moreno from the Salamanca refinery and this will be extended to Guadalajara and Aguascalientes. The latter branch may later be extended north as far as Torreon, via Zacatecas; the Monterrey branch to include Saltillo. The 16-in. gas line from Monterrey to Saltillo is finished. Not shown, the Atzcapotzalco crude and gas lines are due for a capacity increase, the crude line by sectional replacement; gas by pressure increase.

The first of three new, identical West Coast refineries probably will be built at Mazatlan, followed by one at Guaymas and with Salina Cruz last. Ultimate capacity will be 15,000 b/d each with initial size 10,000 b/d but incorporating appropriate provisions for the increase when potential changes into actual demand.

Improvements to existing plants will be discussed subsequently in connection with them. In the "thinking" stage now are one or more possible refineries in the interior to receive crude by pipeline from the coast. But these now are too indefinite to warrant discussion at this time.

(Continued next month)

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Sr. Bermudez

Sr. Colomo

Sr. Corcuera

Sr. Buenrostro

Meet the Refinery Bosses of Petroleos Mexicanos

Three men are responsible for all refining operations of Petroleos Mexicanos. Two of them also have other important duties in the organization.

* * *

Sr. Antonio J. Bermudez, now started on his second 6-year term as Director General (equivalent to president) is a distinguished business man and legislator of Mexico and is Pemex's highest administrative officer.

Having become prosperous in business in Northern Mexico, Sr. Bermudez was persuaded to accept numerous important positions in his native state, culminating in his election as a Senator. In 1946 he was appointed Director General of Pemex by the then President of Mexico, Don Miguel Aleman.

The six years following saw great changes in Pemex. Its work was greatly expanded, two new refineries were designed and completed, new products and crude pipe lines were installed, great emphasis was placed on finding additional crude reserves and increasing production, and important future policies were prepared. In view of his outstanding achievements, the recently-elected Mexican president, Adolfo Ruiz Cortines, reappointed Sr. Bermudez to his second term as Director General, a sharp break with precedent.

Sr. Bermudez (he is no longer Senator) is well-thought-of by his associates in Pemex. The lowliest laborer, if he feels he has been shabbily treated, can appeal his case to the Director General, and will be given a personal hearing if he asks. Seldom does the Director spend a relaxing week-end; instead he will be found at one or another of Pemex's properties, getting a first hand impression of what is going on. Independently wealthy, it is said he has never cashed a salary-check but instead apportions his annual pay among various charitable and social-work organizations throughout Mexico. He pays his own travel expense also.

Sr. Jose Colomo is Sub-Director Tecnico de Produccion for Pemex, equivalent to vice president of refining and production operations, which also includes exploration and most of the pipeline operations. He has spent almost all his life in public service.

Graduating in Petroleum Engineering in 1922, Sr. Colomo joined the Petroleum Division of the Ministry of National Economy. He ultimately became head of this group, and played an important role in formulating the Mexican petroleum laws.

When the "Administracion General del Petroleo Nacional" (A.G.P.N.) was organized in 1935 to produce and refine crude oil from government-owned properties, Sr. Colomo was this agency's first advisor.

Then came the Expropriation Law of 1938, under one of the provisions of which Pemex was created. When the Division of Coordination and Technology (Oficina de Coordinacion y Estudios Tecnicos) was formed, Mr. Colomo was placed at its head. In 1949 he was named to his present post upon the death of Antonio J. Amor, to fill out his unexpired term. Last December he was reappointed for a full 6-year term.

Besides his important duties in government agencies and with Pemex, Sr. Colomo has maintained a strong interest in education. Since 1931 he has been teaching Petroleum Engineering at the University of Mexico.

Sr. Carlos L. Corcuera, Gerencia de Refinacion (manager of refining) for Petroleos Mexicanos, is another who has spent most of his life in oil. Born in Mexico City in 1906 and reared in Jalisco, he graduated in industrial engineering at the University of Cambridge, England, to return as manager of his father's hacienda at Jalisco.

In 1931 he joined British Shell (Compania de Mexicana de Petroleo el Aguilar) as a chemist in the Madero refinery, Tampico. The next year he was shifted to Mina'itlan in the cracking department and finally became distillation superintendent before returning to Tampico in 1936 as acting chief chemist first, and finally assistant operations superintendent in charge of process engineering in wax and cracking departments.

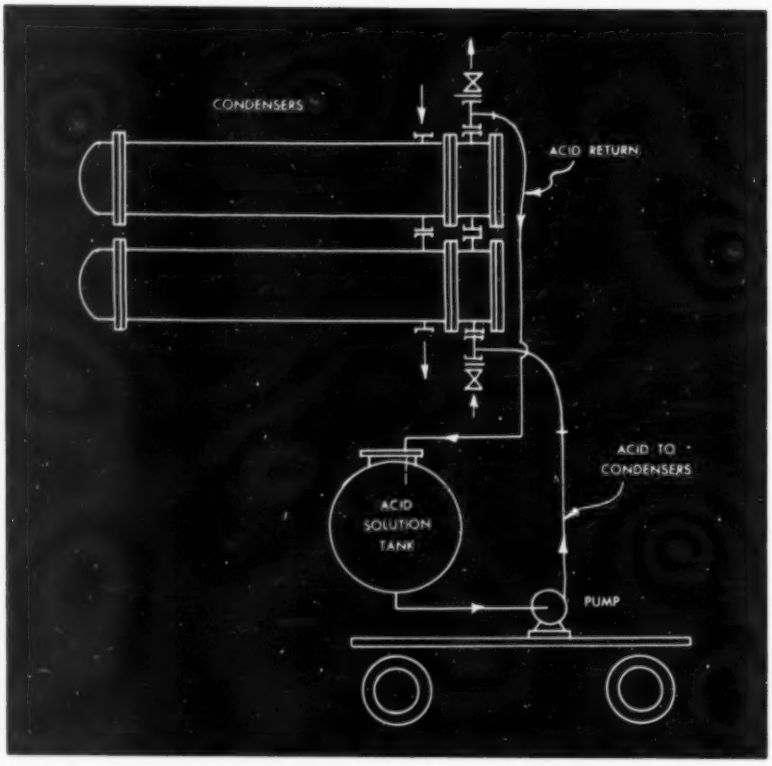
Following nationalization of the oil industry in 1938 he was appointed manager of refining, a post he has occupied with distinction during the amalgamation of the various refining plants into a single company and the great expansion and relocation of refining operations since.

Sr. Efrain Buenrostro was Pemex's first Director General—there have been only two—and faced the man-killing job of amalgamating the various oil companies into a single, smoothly-functioning company following nationalization in 1938. This job required an enormous amount of foresight and a vast capacity for an immense amount of detail work. Sr. Buenrostro had both in good measure and also long experience in governmental affairs.

Prior to coming with Pemex he had held several posts in the diplomatic service and for a time was Mexico's Consul General at San Francisco.

Following this he occupied numerous posts of great responsibility in the financial and economic ministries of Mexico; was once undersecretary of the National Treasury.

Finally, during his term as Secretary of National Economy, he faced the difficult problems and exacting negotiations created by the nationalization of the oil industry. Among his other duties also was that of chairman of the board of directors (Consejo de Administracion) of Pemex.



In-Place Tube Cleaning Pays

Shutdown cycle extended 50%, heat transfer improved 75%, and cleaning time cut by 75%

IN-PLACE, acid-cleaning of non-ferrous tube-and-shell heat exchange equipment is paying off for Lago Oil & Transport Co. at its refinery in Aruba, Netherlands West Indies.

The method, using muriatic acid, is particularly effective in removal of sea-water scale from the tube insides. Acid is circulated by a comparatively simple, shop-built unit which is hooked up to suitable pre-installed connections on each condenser or cooler.

Thus one exchanger in a bank can be taken off stream temporarily for a cleaning job while the remaining exchangers stay in operation. Advantages of the method, as reported to PETROLEUM PROCESSING by L. G. Lopez, light oils superintendent at Aruba, are:

1.—Total manhours and offstream duration of scheduled shutdowns can be materially reduced because scale can be removed from cooling equipment some time before the scheduled shutdown.

2.—Period of time between scheduled shutdowns (for necessary maintenance and repairs) has been extended by 50% and in some cases even more. This is because coolers and condensers, which day by day may be losing efficiency because of scale formation, are quite often the deciding factors as to when an operating unit must be brought down.

3—By cleaning heat exchange equipment in place on an operating unit—and that can be done without any appreciable upset—the unit may be operated longer and more efficiently.

4—The time required to clean a piece of tube-and-shell equipment by acid circulation method has been estimated conservatively at 25% of that required by former methods.

5—Calculations made of approximately 75 exchangers, cleaned over a period of 12 months, showed an average improvement in heat transfer of 75%. In addition, less coolant (sea water) has been used, oil streams to storage have been cooler, and water velocities have been cut (resulting in less damage to tube ends).

Pre-installed connections on the coolers or condensers are relatively simple. They consist of spool pieces between water nozzles and valves at both inlet and outlet—or at least inlet and outlet of a bank or group. The spools have 2-in. flanged stubs which are plated off when the exchanger is in normal operation. Spools also have a thermowell, or a thermocouple connection.

The 2-in. stub is the connection for the chemical cleaning operation (see drawing) but it may be used for back-flushing. It may also be used to attach bleeders, pressure gages, etc., rather than aggravate the original cost of the channel pieces, since the spools are less costly to replace.

It has been found that water streams carrying silt, sand, or other solids will drop these solids out when the stream enters a zone of larger cross-sectional area than that of the inlet pipe because the flow rate drops. Such deposits have been washed out by back-flushing with fire hoses at high water velocities in a direction reverse to normal flow.

When this has been done, as much as 15 to 20°F. improvement has been noted. This practice may also assist in postponing the channel cleaning operation to a more opportune time.

In addition to the spool pieces, spectacle blinds should be inserted between them and the valves. After equipment has been through the acid-cleaning operation, it is wise not to trust the valves any longer. The shell side of the exchanger should also be provided with reliable block valves, 1-in. drains, 1-in. vents, and spectacle blinds on the equipment side of the block valves. It is extremely important to insure against the possibility of gaseous hydrocarbons leaking into the tube side of the exchanger.

The following procedure outline, based on a number of years of practice and experience with the acid cleaning method, assumes a bank of two condensers, equipped and prepared as described above, are about to be cleaned:

1—Shells are blinded and then gas freed.

2—Shell covers are removed.

3—Water valves are blinded.

4—Channel cover plates are removed.

5—All solids are removed from the water side of the tubes.

6—All tubes are cleaned.

7—The inner surfaces of the channel pieces and the floating tube-sheet covers are cleaned.

8—The units are re-assembled.

The solution circulating equipment is mounted on a wheeled platform. It consists of the necessary special alloy pumps, lead-lined tank and piping, acid-resisting 2-in. rubber hose. The strength of the acid depends upon

the number of exchangers to be cleaned. At its highest, it will consist of two parts water and one part by volume of 20° Be. commercial muriatic acid. For the sake of economy it may be wise to keep the acid solution weak and circulate it for a longer period of time. The equipment is connected for an upward flow, as shown in the drawing.

Circulation need not exceed 15 minutes if the strong solution is used (two parts water, one part acid). A reliable indication of the solution having accomplished its purpose is its appearance returning to the tank. There will be a sudden stop in foaming, although the foaming might continue inside the tank.

After the required circulation, the mixture is returned to the tank. Condensers, or coolers, are then washed thoroughly with water and tested for leaks. They can then be returned to operating service after removing blinds, etc.

It is the practice at Lago to sample the acid mixtures before and after circulation. Samples are tested for actual acidity content, both for record purposes and to guide the cleaning crew as to the required circulation for any following cleaning.

The test is very helpful, Mr. Lopez pointed out. On one occasion a condenser with a brand new bundle in it went through the acid cleaning operation by mistake. The test showed the acid returning to the tank from the bundle was undergoing no reaction and was not being consumed.

All plant safety rules are followed closely to prevent accidents resulting from acid spills when large numbers of the repair forces may be present. In fact, the work is planned for times prior to scheduled turnarounds so that large groups of refinery maintenance personnel will be absent.

Economy in acid usage can be obtained to a great extent by close estimates of the expected consumption of acid per square foot of surface to be cleaned, observed thickness of the scale, and regulation of the circulation time.

For closely estimating the service life left in any given tube bundle, a test by Probolog is desirable. Such a test is more accurate when performed immediately after an acid cleaning.

The control of the water outlet pressure and temperature of aboveground condensers should be made at ground level. However, there should be a positive pressure and not over 115° F. temperature at the outlet of the topmost condenser. Any acid which has to be dumped to the sewer must be mixed with a copious stream of water.

Records should be kept from the time the exchangers are installed The chemical cleaning cycle, or schedule, should be noted. These records should also show the strength of the acid solution last used, the length of time for circulation, acidity after circulation, and any other pertinent data.

PORTABLE EXCHANGER CLEANING UNIT out on the job at Aruba

It is most important that the cleaning crews be properly trained and educated to the advantages of the method. As in every procedure, success depends on the training and the interest the crew has in making a go of it. At Lago, it has been found frequently that the performance of only half a group of condensers after cleaning will be equal to, if not better than, that of the entire group before cleaning.

Acid cleaning has replaced dry sandblasting at Lago for the removal of sea water scale. Sandblasting was unsatifactory for a number of reasons, among them:

1—Exchangers were cleaned during scheduled shutdowns only.

2—A number of hazards were involved in using heavy lifting and hauling motorized facilities, particularly at installations processing highly volatile products.

3—The units had to be completely disassembled, the bundles removed from the shells, and hauled to and from a conveniently located sand blasting area in the field.

4—There was no control of metal loss from sand blasting.

5—Incomplete scale removal was often obtained. This appears to accelerate scale formation during subsequent runs, in many instances causing tubes to become completely plugged and require renewal.

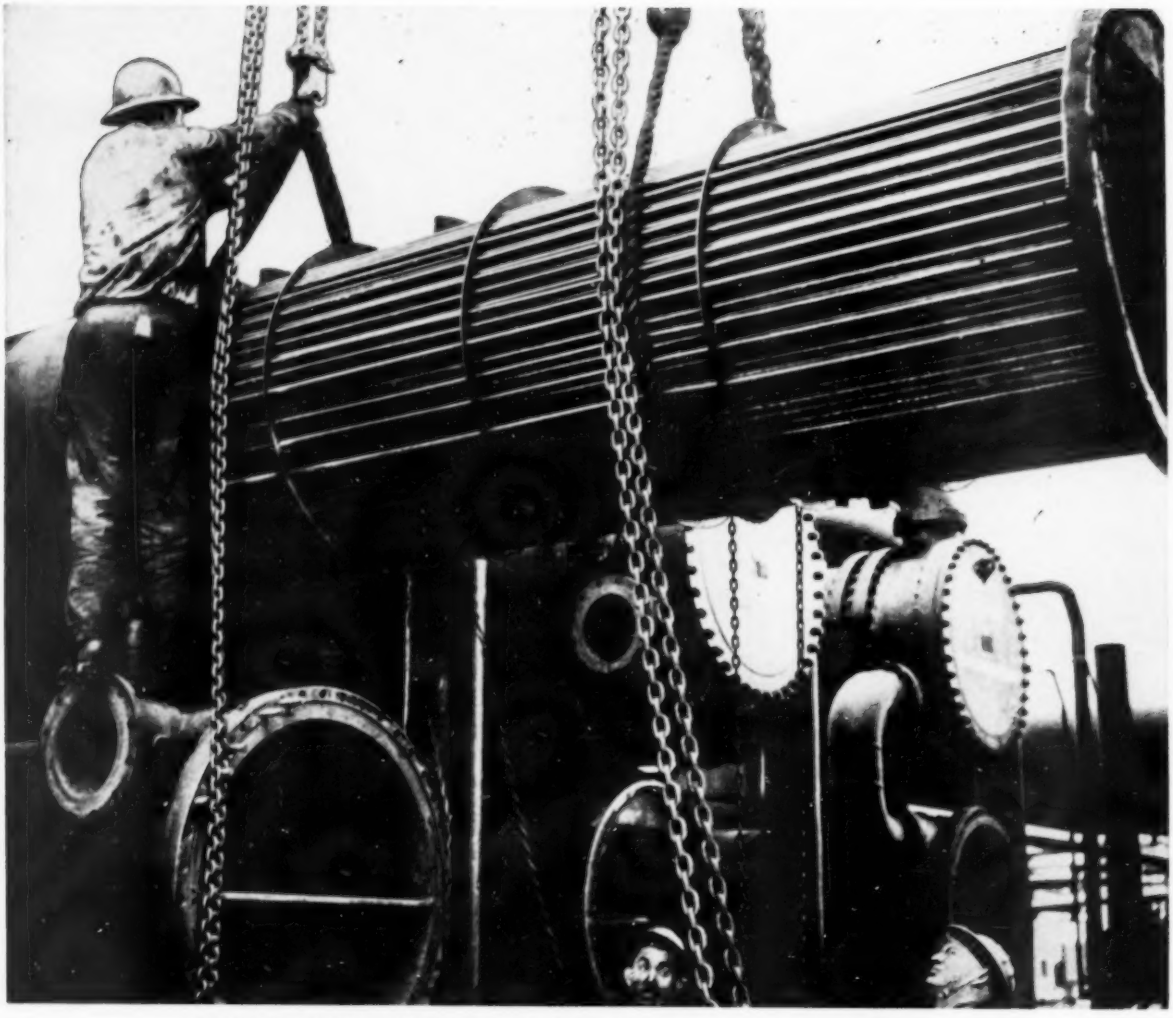
6—Bundles were often damaged by improper handling.

The refinery at Aruba uses sea water as a coolant, of course, by necessity. However, many coastal refineries and petrochemical plants in the United States are faced with the same situation and problem. It has been the practice at Aruba to gradually replace, in all older equipment, the proper sea water corrosion-resisting parts; such as channel pieces, cover plates, floating tube sheet covers, etc.

As far as they have been able to determine, according to Mr. Lopez, there is no method other than the acid cleaning technique to remove sea water scale better or faster. In fact, he explained, it appears as yet that even with chlorination* and other treatments of sea water, the formation of scale in non-ferrous tubes will still continue until a way is found to prevent its forming.

The natural formation of such scale is also experienced in equipment other than shell-and-tube condensers and coolers: for example, internal combustion engine water jackets, compressor water jackets, gas cooling installations, and air conditioning equipment, and particularly where untreated water must be used.

*See PETROLEUM PROCESSING, November, 1952, pp. 1640-1644, "Dow Conquers Sea Water Corrosion," by D. F. Thornton, Jr.



PROTECTING EQUIPMENT against the "disease" of corrosion calls for a well-organized campaign of regular inspection, planned and directed by . . . .

Your Corrosion Engineer

• What ATTRIBUTES Should He Have?
• What DUTIES Should You Give Him?
• What RESULTS Can You Expect?

By F. L. LAQUE

International Nickel Co. Inc.

WHAT can management expect from a corrosion engineer? The question is appropriate, since corrosion engineering is a relatively new addition to the many practices of applying special knowledge that carry the names of the several other branches of engineering. It is reasonable for a refiner, when called on to invest in a corrosion engineer, or in a corrosion engineering department, to inquire as to what he may expect to secure from his investment.

In providing an answer, for the consideration of the refinery management, it is convenient to divide the question into three parts and consider them separately. The answers to three sub-questions will serve to answer the main issue:

First; What are the attributes of a corrosion engineer?

Second; What duties can he be expected to undertake?

Third; What may be anticipated as a result of his activities?

We can take these points up in turn.

Table I lists the attributes of a corrosion engineer. While most of the items are self-explanatory, a few words of comment are in order.

HIS ATTRIBUTES

1 — Knowledge of Corrosion — It seems obvious that before anyone can undertake anything but trial and error or empirical methods of solv-

ing corrosion problems he must have basic information as to the nature of corrosion and the mechanics of corrosion processes. With such knowledge he can make a quicker and surer diagnosis or analysis of any problem that comes up and be in a much better position to reason from one experience to another. It will also permit him to appraise information presented to him, plan research to uncover new information and interpret and apply results of investigations when they have been completed.

2—Knowledge of Corrosion Resisting Characteristics of Materials—No one can expect to choose the proper material to overcome a corrosion problem unless he knows what materials are available and something about their corrosion resisting qualities—advantages and limitations. He doesn't need to keep all of this in his head, but he should know where to find information when he needs it. This may be located in books or other publications in his library or files or he may know where it is most likely to be secured elsewhere by telephone, telegram, mail, or direct consultation.

3—Knowledge of Corrosive Characteristics of Chemicals—In dealing with a corrosion problem the nature of the corrosive medium is obviously as important as the properties of the metal that may be corroded. It is, therefore, necessary to know a good deal about the corrosive characteristics of the chemical or chemicals involved and how these are affected by such factors as concentration, temperature, velocity, aeration or the presence of oxidizing or reducing substances or special contaminants of one sort or another. This will obviously influence the choice of material or indicate what changes in important environmental factors may be expected to have a favorable effect in reducing corrosion of existing equipment.

4—Information on Physical and Mechanical Properties of Materials—Resistance to corrosion alone is not sufficient to qualify a material for a particular service. It also must be strong enough to sustain the mechanical stresses that may be encountered. Thermal conductivity may be important where high rates of heat transfer are required, or the thermal expansion should be such as to permit association with some other material without intolerable distortion or the development of excessive thermal stresses.

5—Information on Availability and Cost—No matter how attractive a material may be from any other point of view, it is of no use for a particular purpose if it cannot be secured in the required form. Filter

Table 1—Attributes of a Corrosion Engineer

1. Knowledge of Corrosion
2. Knowledge of Corrosion Resisting Materials
3. Knowledge of The Corrosive Characteristics of Chemicals
4. Information on Physical and Mechanical Properties of Materials
5. Information on Availability and Cost
6. Information on Fabrication Techniques
7. Knowledge of Special Requirements of What Is Being Produced
8. Proficiency in Planning, Executing and Interpreting Test Programs
9. Ability to Get Along With Others
10. Common Sense.

Table 2—Duties of a Corrosion Engineer

1. Prevent Corrosion
2. Diagnose Failures
3. Overcome Difficulties If They Occur
4. Disclose Opportunities for Improvement
5. Select Best Procedure
6. Set Up Specifications
7. Undertake or Supervise Inspection
8. Establish Preventive Maintenance
9. Record Experience
10. Set up Standards
11. Improve Processes
12. Show a Profit

Table 3—Results of a Corrosion Engineer

1. Maximum Life of New Equipment
2. Preservation of Old Equipment
3. Protection and Improvement of Products
4. Uninterrupted Production
5. No Loss of Product
6. Salvaging of Corroded Equipment
7. Elimination of Hazards
8. Increased Profits

cloth cannot be woven from an alloy available only as castings. Several materials may possess the corrosion resisting and mechanical properties required for a job, but many of them may be too expensive to be considered. Silver might be a little better than nickel for tubes in an evaporator to concentrate caustic soda to 50%, but it wouldn't be enough better to justify its extra cost and maybe steel would be a better choice economically than either for handling dilute caustic under less stringent conditions. For example, steel is the economically practical material for tank cars for shipping concentrated sulfuric acid though there are many strong complex alloys that are corroded much less than steel by sulfuric acid under the conditions that may be encountered in tank cars.

6—Information on Fabrication Techniques—A corrosion engineer must not only be familiar with all the common practices in the working and fabrication of metals, but he must also know which materials are amenable to fabrication by the procedure that is to be used. There is no use in choosing a metal that cannot be welded for a vessel that cannot be fabricated in any other way, nor in specifying an alloy that can be machined only with difficulty for some complicated part that must be finished to close tolerances and be capable of being turned out in quantity on automatic machines at a reasonable cost.

7—Knowledge of Special Requirement of What Is Being Produced—It is often necessary to choose materials so as to avoid any chance that significant amounts of particular metal compounds may be picked up by the product so as to impair important properties such as clarity, color, flavor, strength, keeping quality or otherwise restrict the opportunity for its use and sale in some important market.

8—Proficiency in Planning, Executing and Interpreting Test Programs—Frequently, existing information must be supplemented by developing new data needed to solve a particular corrosion problem. It is necessary to be familiar with the several types of corrosion test that may be made and the advantages and disadvantages of each so as to choose the best means of attack. The techniques of carrying out the required tests should be understood so that the tests may be made properly. The limitations of the tests must be appreciated so that the results of tests made by anyone may be appraised properly and applied intelligently.

9—Ability to Get Along With Others—The work of a corrosion engineer will bring him into frequent contact with responsible people in many other branches of his organization.

For example, he should work closely with the engineering staff in working out new designs or modifying existing ones so as to reduce the opportunity for corrosion.

He should remain in close contact with the maintenance engineers so that the details of difficulties and their probable causes may be ascertained and so that suggestions may be made as to the best way to cope with them in making repairs or, better still, avoid them by preventive maintenance.

He should work with the production department so as to be aware of their particular requirements and needs for improvement with respect either to more dependable operation of equipment or better quality of product as these may be affected by corrosion.

He will require the help of, and can be helpful to, the accounting department in establishing the actual cost of corrosion in each case and the savings that may be effected by reducing losses from this source.

He must work closely with the purchasing department in guiding the choice of materials for particular purposes in working out specifications for materials, equipment and fabrication procedures and in arranging for such inspection as may be required.

He should assist the sales department by helping discover any deficiencies of the product that might be corrected by a better control of corrosion and by demonstrating the sales value of the improvements that result from his activities.

Finally, he must keep management informed of his needs and his accomplishments so that he may be provided with the support he will require to be effective.

10—Common Sense—No comment is required beyond the reminder that all of the other attributes will be increased in value many fold if they are always used with common sense.

HIS DUTIES

Table 2 lists the duties and responsibilities the corrosion engineer may be expected to assume and some brief discussion on these points follows:

1—Prevent Corrosion—It is much more sensible and valuable to prevent corrosion than to be able to explain why it occurred, suggest what should have been done to avoid it, or prescribe how the damage may be repaired. Civil engineers are quite properly concerned more with designing and building bridges that don't fall down than with rebuilding them after failure. If given the opportunity at the proper time, a good corrosion engineer should be able to guide design and specify materials and how they should be fabricated so that costly corrosion failures should be as rare as catastrophic failures in structural engineering.

2—Diagnose Failures — Whenever corrosion occurs in spite of efforts to avoid it or because nothing was done to prevent it, the corrosion engineer should be familiar enough with corrosion processes and the types of corrosion to be able to diagnose the case and decide what must be done to correct the situation so that the failure will not be repeated soon again. This may require the use of laboratory tools for study of corrosion products, metallographic examination of the attacked metal and

Meet the Author

F. L. LaQue, New York, in charge of the Corrosion Engineering Section, Development and Research Division, International Nickel Co., Inc., graduated in chemical and metallurgical engineering from Queen's University, Kingston, Can., in 1927. He shortly went to work in the INC Development & Research Division, specializing in the properties and application of corrosion resisting materials. Previous to his present position he served as Assistant Director of Technical Service.

Among outside activities Mr. LaQue has served as president of the National Assn. of Corrosion Engineers. He received the F. N. Speller Award in Corrosion Engineering in 1949 and delivered the Edgar Marburg Memorial Lecture of the ASTM in 1951. He is at present connected with various committees having to do with corrossion problems. of the ASTM and the National Research Council.

chemical analysis of the affected material. Even if the corrosion engineer is not called upon to undertake the several types of investigation called for, he should know what studies are needed and be able to interpret and apply the results so as to arrive at a proper course for further action.

3—Overcome Difficulties—On the basis of assembled information the corrosion engineer should be able to guide the maintenance department in making repairs most effectively. This may require the substitution of some new material, the remaking of a defective weld or other joint, the application of a patch or reinforcement of some sort, the carrying out of heat treatment, etc. Or, it may require some change in the process setup, such as an increase or decrease of temperature or velocity, the elimination of aeration or an increase in it, the addition of some corrosion inhibiting compound or the elimination of a corrosion accelerating one.

4—Disclose Opportunities for Improvement—It is not sufficient to wait until serious corrosion has occurred to do something about it. Frequently, corrosion can be detected before it has become serious and steps may be taken to arrest it—as by some change in the solution being handled or in the conditions of service.

5—Select Best Procedure—Usually there are many ways by which a corrosion problem might be solved—as by changing the material being used, fabricating it in a different way, applying cathodic protection, eliminating some corrosive contaminant, adding an inhibitor, altering temperature, velocity or aeration in a favorable direction. The corrosion engineer must consider all these possibilities and select the best procedure on the basis of such considerations as:

a. reliability
b. applicability
c. cost
d. expediency

6—Set Up Specifications—Once a material and method of fabrication have been selected, the corrosion engineer can be helpful in drawing up specifications to insure that the material delivered will be of the proper composition and quality and that it will be fabricated in a way that will insure good performance in resisting corrosion.

7—Inspection—The corrosion engineer may inspect materials prior to fabrication, or fabricated equipment before delivery, to be sure that there are no defects or departures from specification that might impair resistance to corrosion.

In addition, periodic inspection of existing equipment should be undertaken so that any corrosion may be detected in time to initiate corrective action or to avoid hazards or interruptions of production that would accompany an unexpected failure from corrosion. This inspection may be done by the corrosion engineer or he may set up a schedule to be followed by others.

8—Preventive Maintenance—Recognizing opportunities for corrosion difficulties the corrosion engineer may establish techniques and a schedule of maintenance measures that will deal with serious corrosion before it occurs or before it has advanced to the stage where it will be more difficult to cope with.

9—Record Experience—It is very desirable to maintain records of experience with equipment subject to corrosion. A log sheet or ledger should be kept for each major item. This will describe the materials and fabrication procedure for the initial installation, the occurrence of any significant corrosion and whatever is done to remedy the difficulty by a change of material, process detail or the addition or removal of some minor constituent of the process solution. In this way repetition of unsuccessful trials of different materials or process changes will be avoided. The circumstances surrounding the recurrence of the same trouble will become clearer so that the important details will be emphasized and the most likely direction of action towards improvement will be indicated.

10—Set Up Standards—It is possible very often to effect substantial savings by reducing the cost of spare equipment, parts and materials kept on hand to deal with emergencies that may result from corrosion failures. For example, more or less standard valves and pumps made of a limited number of materials may be capable of use with several processes involving different corrosive media. A few sizes of pipe may be adequate for many purposes. Heat exchangers may be designed to use tubes of a few standard diameters, gauges and lengths. This principle extends as well to packing and gaskets and other incidental items.

11—Improve Processes—By studying flow sheets and process details from the corrosion point of view it is often possible to suggest changes that will prolong the life of the materials in use or permit the use of cheaper materials. Along with this is the opportunity to improve the product by eliminating or reducing the pickup of corrosion products that may be detrimental to quality. In extreme cases, process modifications to deal with corrosion may be required in order to make it economically practical to carry out a process at all.

12—Show a Profit—Whatever the corrosion engineer recommends to cope with corrosion must always take into consideration the economic details so that the results secured will be worth more than it costs to achieve them and so that the most economical of several possible solutions to a problem will be recognized and chosen in preference to the others.

HIS RESULTS

Table 3 lists the principal results to be expected from the work of the corrosion engineer.

From the point of view of management, the results of the activities of a corrosion engineer may be expected to show up in the form of:

1—Insuring maximum life of new equipment.

2—Preservation of existing equipment.

3—Protecting or improving the quality of a product so as to make it saleable by maintaining or improving a competitive position.

4—Avoiding costly interruptions of production.

5—Reducing or eliminating losses of valuable products by spillage, e.g. from leaks in vessels or piping.

6—Salvaging of equipment withdrawn from service because of corrosion. This may involve patching holes, remaking joints, replacing tubes, restoring worn or corroded surfaces by welding or metallizing and the like.

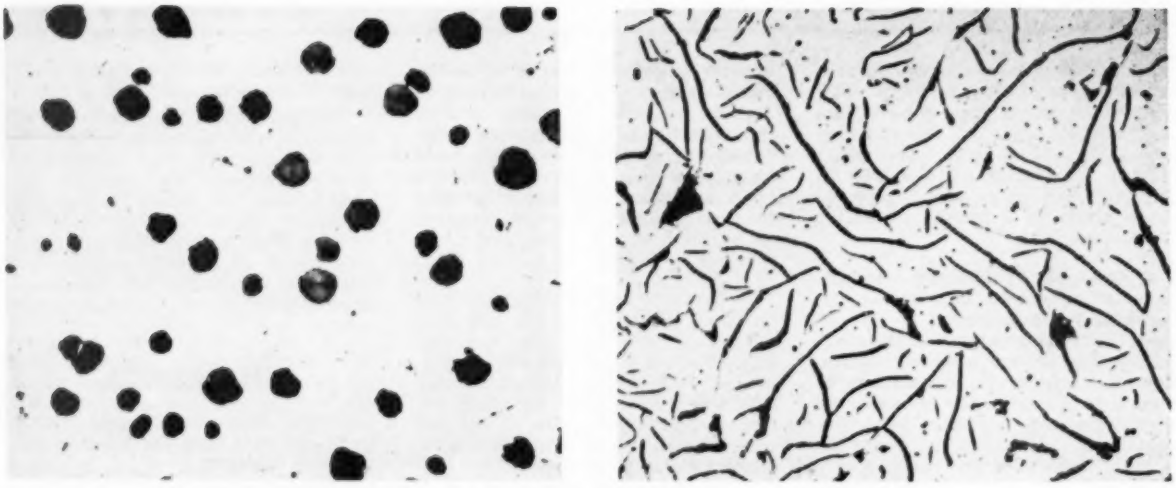
7—Eliminating hazards to life and property that might be associated with corrosion. Examples are explosions of pressure vessels or piping systems as a result of stress corrosion cracking or other forms of localized attack, release of poisonous or explosive gases or vapors, etc.

8—Increased profits — Given the required support and tools to work with, any good corrosion engineer should be able to effect savings that will amount to at least ten times his salary each year. These savings or increased profits will stem from lower manufacturing and maintenance costs and an improved competitive position due to such lower costs plus an improved product.

While corrosion has nothing but negative aspects from most points of view, money spent to enable a corrosion engineer to control corrosion will be returned many fold and will represent one of the most profitable investments that can be made.

Acknowledgement

The remarks by Mr. LaQue on what refinery management may expect from the corrosion engineer were originally presented at a Corrosion and Alloys Forum, sponsored by Williams & Co., in Cleveland, Sept. 25, 1952.



UNIQUE CAST IRON results when graphite forms spheroids (left) instead of plates or flakes (right), providing continuity of metallic structure

DUCTILE CAST IRON

Where can it be used in process equipment?

DUCTILE cast iron, known as the "cast iron that bends," is receiving a close scrutiny by the petroleum processing industry. Some oil companies have already secured castings of the new metal for experimental purposes, and are studying its possible applications in refinery and natural gasoline plant service as a replacement for some grades of steel as well as the conventional gray cast iron.

As far as is known, the material has not yet appeared in oil company specifications. However, the American Society for Testing Materials has written one specification covering two grades of the ductile iron (see Table 1) and the Navy has included the material in some of its standards.

Because of the manufacturing method, as well as its properties of ductility, pressure tightness, strength, wear and others; ductile iron is believed to possess many advantages for industrial and process applications. It can be used in many ways in the as-cast condition, in sections of a wide range of sizes and weights. It can also be heat-treated in 8 hrs. or less to meet more severe requirements. It is said to be readily welded by the same techniques as those used for gray iron.

Ductile iron was developed after many years of research in the laboratories of International Nickel Co., to whom patents have been issued. In the main, its production differs from gray iron in that about one pound of magnesium is retained in one ton of iron in the process.

The magnesium controls the form of the graphite. Ductile iron contains graphite in the form of compact spheroids, or nodules, tending to have a smaller surface area-to-volume ratio than the graphite in gray iron. Consequently, the continuity of the matrix is more nearly preserved and there is less notch effect.

This characteristic is said to provide a high order of tensile strength and ductility. In gray iron, the graphite occurs in the form of flakes and plates, which have a large surface area-to-volume ratio, and break up the continuity of the metallic matrix. The photographs show the typical microstructure of the two types of iron.

One refinery application for ductile iron being investigated is in small pumps and valves, which are subject to moderate operating and corrosion conditions, since alloyed ductile iron is not yet generally available. The casting characteristics of ductile iron facilitate the production of pressure tight castings. For this reason, as well as for its desirable mechanical properties, use is seen for the material for valves, pump casings, flanges, and other pressure tight applications.

Complex valves made formerly in bronze are now being made of ductile iron, because a high percentage of leaky castings could not be avoided with bronze. Ductile iron pipe and pipe fittings have been approved for use up to pressures of 2000 psi.

Water, oil, and gas lines, under certain conditions, are also seen as a possible application of ductile iron at refineries. The ductility of the new metal would tend to prevent breakage from strain that occurs with ordinary cast iron pipe. Some tankers in foreign service are already using ductile iron oil lines to avoid the damage usually experienced from the heaving of the vessel.

Structural supports, platforms, and stair treads may possibly be redesigned to reduce weight substantially if ductile iron is used to take advantage of its high mechanical properties.

Bubble caps and trays for fractionating towers was one of the early refinery applications for ductile iron. The breaking of the teeth on the bottom skirt of a cast iron bubble cap has long been a refinery operating problem. The use of the new material permitted the cold straightening of bubble cap teeth or of warped trays.

Table 1—ASTM Tentative Specifications for Nodular Iron Castings, A339-51T

Grade	Usual Conditions	Strength, psi.		Percentage Elongation
		Tensile	Yield	
80-60-03	As cast	80,000	60,000	3.0
60-45-10	Annealed	60,000	45,000	10.0

Bolted couplings is the subject of experimental work reported by some manufacturers on the use of ductile iron. Tentative results indicate such improvement over previously used materials that redesign for weight reduction may be possible.

Bushings, bearings, cylinder liners, and piston rings are said to be equipment where the new cast iron is a desirable material because of its resistance to wear, seizing, and galling. In one experiment, gears made of ductile iron showed no pitting, and the only evidences of wear were burnished appearances on the edges of the teeth.

Tube supports, hangers, burner castings and similar parts should give good service life when made of the iron according to test results, particularly where moderate temperatures prevail.

An interesting property capable of being developed in ductile iron, it is reported, involves the manufacture of a casting with a hard, abrasion-resistant face and a ductile back. This was accomplished by casting the working surface of the part against a chill and thus obtaining high hardness on the surface while the unchilled portion of the casting remained machinable and ductile. It is believed this property may be applicable to parts handling abrasive catalysts in catalytic cracking units.

At present approximately 200 companies, operating 500 to 600 foundries worldwide, are licensed to produce ductile iron. The volume of its production in the U. S. and Canada in 1952 is expected to reach 80,000 to 100,000 melt tons, as compared with about 50,000 melt tons in 1951.

With the introduction into commercial practice of ductile iron, many markets now being served by wrought steel may become available to the foundry industry, International Nickel Co. officials believe. Of the 5,000,000 tons of steel pipe made annually in the U. S., some proportion can be adequately and economically served by the new spheroidal graphite iron. Oil well casing, pipe for the chemical industry, piling for buildings and high pressure transmission lines are examples, it is said.

Ductile iron, it is reported, can be readily arc welded following the techniques established for gray iron. Examination of a number of electrodes has indicated that the best type consists of a nickel-iron core wire with a carboniferous coating similar to Ni-Rod "55". With the proper techniques it is said to be readily possible to make welds under a variety of conditions.

A number of ductile iron parts are now being welded in routine fashion to steel, to highly alloyed materials and to ductile iron itself. The tensile strength of the weld metal is about 60,000 psi. and the amount of ductility will range up to 10% or higher, depending on the welding and thermal conditions. Welded joints in ductile iron pipe, welded without preheat or post-heat, have been shown to be stronger than the pipe itself under hydrostatic conditions. Ductile iron is being used in several applications solely because of its weldability.

Following is a brief review of some of the aspects of ductile iron, as presented recently by Albert P. Gagnebin, of the Development and Research Division of International Nickel, before a group of editors of technical journals, including PETROLEUM PROCESSING, at the Company's Bayonne, N. J. laboratory:

Ductile iron is not a single material, but rather a family of materials. Like steel, it is susceptible to alloying and heat treatment, which bring about great changes in its properties. Starting with a soft plastic ferrite having a hardness of 160 Brinell, tensile strength of 65,000 psi. and 25% elongation, the structure may be hardened and strengthened up through the pearlitic and acicular grades, finally reaching the martensitic grade, which is the structure found in quenched steel. This might have a hardness of 600 Brinell and a strength in excess of 200,000 psi.

It is also possible with appropriate alloys to develop an austenitic structure, which is the structure occurring in some grades of stainless steel.

One useful concept of ductile iron is that it is a graphitic steel. The graphite in it has an important bearing on its properties, not only those such as wear resistance and machinability, but also on its process properties. The graphite is uniformly distributed throughout its structure and therefore might be expected to modify the mechanical properties somewhat. Broadly speaking, the properties of ductile iron deviate only 10 or 15% from those in cast steel having similar microstructure. A combination of 135,000 psi. tensile strength, with 7% elongation in the quench and drawn condition, has been demonstrated.

Ductile iron has the same quality of fluidity as high carbon, cast iron, one of the most fluid foundry alloys.

The heat and oxidation resistance of ductile iron is exceptional, primarily because of its favorable structure. The graphite is distributed in spheroids, thus the structure resists the penetration of oxidizing gases. In contrast, the structure of gray cast iron permits easy entrance of these gases, leading to the early destruction of the metal when exposed to elevated temperatures.

The wear resistance of ductile iron is one of its outstanding properties, because the graphite embedded in the structure tends to give it a self-lubricating quality. Recent tests showed the wearing quality of ductile iron to equal that of leaded bronze, which is a bearing metal.

The composition range and mechanical and heat treated properties of ductile iron are shown in Tables 2, 3, and 4.

Table 2—Representative Mechanical Properties of Commercial Heats of Ductile Iron

Strength, psi. Tensile	Strength, psi. Yield	% Elongation	Brinell Hardness	Usual Condition
95-105,000	70-75,000	2.5- 5.5	225-265	As cast
85- 95,000	65-70,000	5.5-10.0	195-225	As cast
65- 75,000	50-60,000	17.0-23.0	140-180	Annealed
85- 95,000	65-75,000	1.0- 3.0	230-290	As cast

Table 3—Heat Treated Properties of Ductile Iron

	Strength, psi. Tensile	Strength, psi. Yield	Elongation % in 2 in.
NORMALIZED AND DRAWN			
Air cooled from 1600° F.	135,750	89,250	7.0
Air cooled from 1600° F.; drawn at 1100° F.	137,000	93,000	7.0
Air cooled from 1600° F.; drawn at 1200° F.	138,000	95,000	8.0
OIL QUENCHED AND DRAWN			
Oil quenched from 1550° F.; drawn at 900° F.	152,750	136,250	9.0
Oil quenched from 1550° F.; drawn at 1000° F.	152,750	137,250	4.0
Oil quenched from 1550° F.; drawn at 1100° F.	135,500	121,500	7.5
Oil quenched from 1550° F.; drawn at 1200° F.	101,250	84,000	10.0

NOMINAL COMPOSITION, %

Total Carbon	Silicon	Manganese	Phosphorus	Sulfur	Nickel	Magnesium
3.50	2.30	0.35	0.05	0.01	1.25	0.06

Table 4—Composition Range of Ductile Irons

	Carbon	Silicon	Manganese	Phosphorus	Nickel	Magnesium
Broad range, %	3.2-4.2	1.0 -4.0	0.1-0.8	0.10	0-3.5	0.05-0.10
Ferritic, high-ductility	3.6-4.2	1.25-2.0	0.35	0.08	0-1.0	0.05-0.08
Ferritic, high-strength	3.4-3.8	2.25-3.25	0.35	0.10	0-1.0	0.05-0.08
Pearlitic, high-strength	3.2-3.8	2.25-2.75	0.6-0.8	0.10	1.5-3.5	0.05-0.08

How Paraffin Content Effects Quality Of Motor Fuels from Platforming

By VLADIMIR HAENSEL and G. R. DONALDSON
Universal Oil Products Co., Chicago

A comparison has been made of Platforming of two straight-run naphthas, having widely different paraffin contents. The Platforming operations were carried out in continuous bench scale units employing gas recirculation. Data were obtained throughout the conversion range of 73 to 99 F-1 clear octane number of the debutanized Platformate.

The results obtained indicate that the paraffin hydrocarbons in the low naphthene content feed undergo extensive dehydrocyclization and thereby contribute substantially to the upgrading of the charge. The observed yield differential between low and high paraffin content naphthas at the 95 F-1 clear level was 8.5 LV% of the charge. Approximately 5 LV% can be charged to the lower quality (octane number) of the high paraffin content stock. The balance of this yield differential is associated with the inherently greater volumetric yield losses in the case of dehydrocyclization of paraffins as compared with dehydrogenation of naphthenes to produce aromatics and the greater extent of hydrocracking that accompanies dehydrocyclization.

Meet the Authors

Vladimir Haensel received his M.S. from the Massachusetts Institute of Technology in 1937. He joined Universal Oil Products Co. as an assistant to Professor V. N. Ipatieff. In 1939 he helped to set up the Ipatieff High Pressure Laboratory at Northwestern University. He received his Ph.D. from Northwestern in 1941 and returned to Universal as a research chemist. From February to July, 1945, Dr. Haensel inspected the German synthetic oil plants as a member of the Technical Oil Mission for the Petroleum Administration for War. Since August, 1945, he has been the coordinator of the cracking research division of Universal Oil Products Co.

Dr. Haensel

Mr. Donaldson

George R. Donaldson received his B.S. in Chemical Engineering from the University of Wisconsin in 1940. He then joined the pilot plant division of Universal Oil Products Co. In 1943 he became a member of the service department acting as a field representative in connection with the commercial operation of HF alkylation and butane isomerization plants.

Since 1945, Mr. Donaldson has been associated with the cracking research division at Universal's Riverside Laboratories. Mr. Donaldson is a member of the American Chemical Society.

IN previous publications, it has been shown that straight-run gasolines and naphthas can be upgraded into higher octane fuels by Platforming. It has been pointed out that the main reactions involved in Platforming are those of dehydrogenation of naphthenes, isomerization, dehydrocyclization, hydrocracking of paraffins and desulfurization.[1]

The composition of straight run gasolines and naphthas varies considerably. In the upgrading of stocks low in naphthene content the relative importance of the conversion of the paraffins is much greater than in the case with the upgrading of stocks high in naphthene content. In commercial practice, it was found that rather similar yield-octane relationships were obtained in processing either high or low naphthene content feeds, indicating that at F-1 clear octane levels ranging from 82 to 86 there is essentially no difference, from the standpoint of yield of C_4+ product, whether the upgrading is carried out at high or low extents of paraffin conversion.

A further inspection of the reactions of paraffins indicates that upgrading by hydrocracking is not as efficient a method from a yield consideration as dehydrocyclization of paraffins to aromatics. It is apparent that in the higher boiling fractions of the product, there must be essentially no paraffinic constituent, since such paraffinic constituents have too low an octane number to be useful components of the product. Thus, the conversion of these paraffins to aromatics provides for a large gain in octane number without an excessive loss to lower boiling hydrocarbons.

The present work was undertaken in order to evaluate the behavior of two widely different naphthas in Platforming. These stocks are characterized by a large difference in their paraffin content. In one case, a Venezuela naphtha was employed which contained 39 vol.% paraffins, while a Kuwait naphtha, having the same boiling range, was selected as being representative of a high paraffin content, the latter containing 66% paraffins by volume. The Platforming operation was carried out at a variety of severities which included changes in temperature and space velocity at three different levels of pressure.

Apparatus and Procedure

The two charge stocks were prepared by batch fractionations of the respective full-boiling range straight-run gasolines to provide the desired

boiling range straight-run naphthas. Table 1 shows the inspections of the two resulting heart cut naphthas.

These were processed in bench scale type Platforming units. The design of these units incorporates a reaction tube positioned in an electrically heated block furnace maintained at a selected temperature, and the catalyst temperature is measured by means of a movable thermocouple in the coaxial thermowell. The hydrocarbon feed is charged to the top of the reactor by means of a plunger type pump. The units are equipped with a gas compressor which pumps the recycle gas from the high pressure receiver to the reactor inlet. The liquid phase from the high pressure receiver is charged directly to a debutanization column which separates the C_4 and lighter from the C_5 and heavier Platformate.

Recycle gas scrubbers are incorporated in these units to remove H_2S and water from the recycle gas before it enters the reactor. Solid reagents are used in these scrubbers, soda lime to remove the H_2S, and calcium sulfate to remove the water.

The units are equipped with automatic pressure and temperature controllers that function to hold the reactor at the desired pressure and the block furnace at the desired temperature.

The gas streams leaving the unit, namely the excess recycle gas stream and the debutanizer overhead gas stream, are metered and their composition determined by mass spectrometer analysis. The debutanized Platformate produced is weighed, and the C_5 content determined by a precision fractionation. Platformate inspections such as octane number, Engler, etc. are made on the as produced debutanized Platformate.

The separation efficiency obtained in the debutanizer is very good, such that a practically negligible amount of C_4 is left in the debutanized Platformate (0.1% or less), while the amount of C_5 in the gas streams as a rule totals less than 0.5% based on the charge. Thus, corrections to the debutanized Platformate yields and octane numbers to place them on the total C_5+ basis are quite small.

Discussion of Results

In processing two charge stocks of a similar boiling range but widely different cyclic content, the results obtained show the important feature that the production of C_5+ Platformates having 95 and higher F-1 clear octane numbers is readily attained. In spite of the large difference in paraffin content of the two straight-run naphthas, as shown by the data in Table 1, the aromatic productions realized from these two stocks are comparable.

In accomplishing these conversions, the catalyst effects considerably greater extents of dehydrocyclization in the case of the high paraffin content stock. This is shown by the relative magnitude of the values in Tables 2 and 3 under the heading of Net Aromatic Production/Net Theoretical Production from Naphthenes, namely 142-157% in the case of the high paraffin content charge as compared with 78-107% in the case of the low paraffin stock.

The production of aromatics by dehydrocyclization in the case of the high paraffin stock is accomplished somewhat less efficiently, from the standpoint of the yield-octane relationship, than is the case with the

Table 1—Charge Stocks

Paraffin Content	Low		High	
Source	Venezuela		Kuwait	
Composition:	Vol. %	Wt. %	Vol. %	Wt. %
Paraffins	39.4	36.5	66.3	63.3
Naphthenes	39.5	40.1	19.8	20.8
Aromatics	21.1	23.4	13.9	16.9
Properties:				
F-1 Clear Octane Number	52.2		32.4	
F-1 + 3 cc. TEL/gal. octane number	73.6		55.2	
Sulfur, wt. %	0.022		0.064	
Refractive Index, n_D^{20}	1.4379		1.4258	
Dispersion, 20° C.	91.2		83.2	
Gravity, °API @ 60° F.	48.6		54.5	
Specific Gravity @ 60° F.	.7857		.7608	
Engler Distillation:				
IBP, ° F	272		272	
5%	282		280	
10	284		282	
30	292		290	
50	302		300	
70	316		316	
90	338		342	
95	348		348	
E. P.	374		378	
% Bottoms	1.0		1.0	
% Loss	0.0		0.0	
Average Molecular Weight	124		127	
Potential Aromatic Production from aromatics & naphthenes, wt. % of feed	61.6		35.7	
Potential Aromatic Production from naphthenes, wt. % of feed	38.2		19.8	

Table 2—Platforming of Low Paraffin Venezuela Content Straight-Run Naphtha-High Pressure Severity

Severity	1	2	3	4	5	6
Yields:						
H_2 (SCF/bbl. of charge)	503	518	554	559	569	508
Dry Gas (C_1-C_3) (SCF/bbl. of charge)	91	131	178	223	261	308
C_4H_{10}, liq. vol. % of charge	3.0	4.2	5.3	7.8	8.2	9.5
C_5H_{12}, liq. vol. % of charge	2.9	3.8	5.4	6.6	7.5	8.8
C_5 + Platformate, liq. vol. % of charge	92.2	90.0	87.4	83.9	82.2	79.9
Properties of C_5 + Platformate:						
F-1 Clear Octane Number	83.2	87.6	92.3	96.1	96.9	98.7
F-1 + 3 cc. TEL Octane Number*	93.8	97.0	98.6	+.04 cc.	+.11 cc.	+.23 cc.
Aromatic Content, Wt. %	53.7	58.1	63.0	69.0	72.1	74.5
Vapor Pressure, psig.	1.1	1.5	2.2	2.5	2.6	3.5
Gravity, °API @ 60° F.	45.2	45.0	44.3	43.4	43.1	42.9
Specific Gravity @ 60° F.	.8008	.8017	.8049	.8090	.8104	.8114
Engler Distillation, ° F @:						
IBP	174	151	142	140	140	136
10%	260	240	214	206	202	187
50%	300	297	291	292	292	288
90%	350	349	339	339	346	342
95%	366	364	359	360	363	360
E.P.	406	412	412	436	434	434
Conversion Values:						
Aromatic Production, wt. % of charge	50.5	53.4	56.4	59.5	61.1	61.4
Net Aromatic Production, wt. % of charge	27.1	30.0	33.0	36.1	37.7	38.0
Net Aromatic Production, % of net theoretical production from naphthenes	71.0	78.5	86.4	94.5	98.7	99.5

* + cc. denotes iso-octane + cc. of TEL/Gal.

Table 3—Platforming of a Low Paraffin Venezuela Content Straight-Run Naphtha-Intermediate Pressure

Severity	1	2	3	4	5	6
Yields:						
H_2, SCF/bbl. of charge	663	684	699	772	772	702
Dry Gas (C_1-C_3), (SCF/bbl. of charge)	81	99	112	142	182	243
C_4H_{10}, liq. vol. % of charge	2.6	3.9	4.1	5.5	6.5	8.6
C_5H_{12}, liq. vol. % of charge	2.4	3.3	4.0	4.6	5.7	7.4
C_5 + Platformate, liq. vol. % of charge	91.8	90.2	89.5	87.2	85.0	81.6
Properties of C_5 + Platformate:						
F-1 Clear Octane Number	85.7	89.1	90.4	93.3	95.8	98.4
F-1 + 3 cc. TEL Octane Number*	94.8	96.4	97.4	99.0	99.8	+.23 cc.
Aromatic Content, wt. %	56.7	61.0	62.4	68.4	72.0	75.8
Vapor Pressure, psig.	1.1	1.6	1.7	1.9	2.2	2.7
Gravity, °API @ 60° F.	44.1	43.8	43.4	42.9	42.2	41.8
Specific Gravity @ 60° F.	.8058	.8072	.8090	.8114	.8146	.8165
Engler Distillation, ° F @:						
IBP	177	154	165	144	123	136
10%	258	249	248	236	219	202
50%	309	300	301	300	299	294
90%	344	352	355	350	346	350
95%	364	372	373	368	368	367
E.P.	412	416	417	434	430	435
Conversion Values:						
Aromatic Production, wt. % of charge	53.4	56.5	57.5	59.7	63.4	64.2
Net Aromatic Production, wt. % of charge	30.0	33.1	34.1	36.3	40.0	40.8
Net Aromatic Production, % of net theoretical production from naphthenes	78.5	86.7	89.2	95.0	105	107

* + cc. denotes iso-octane + cc. of TEL/Gal.

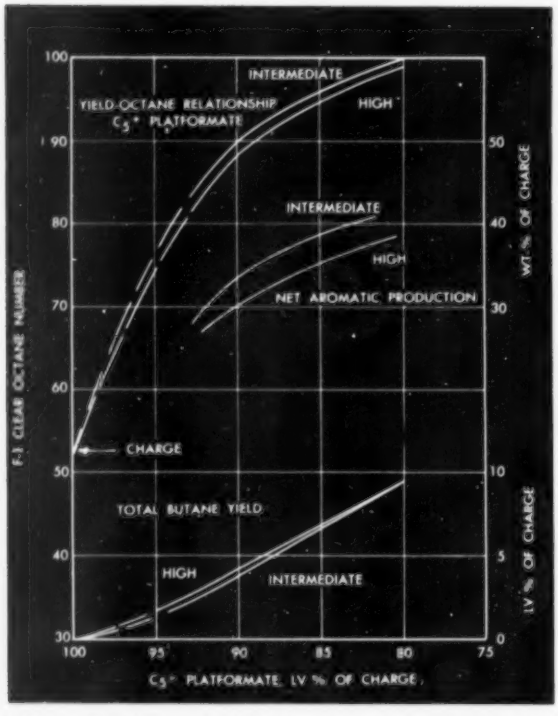


FIG. 1—Results of Platforming a low paraffin content straight-run Venezuela naphtha at intermediate and high pressures

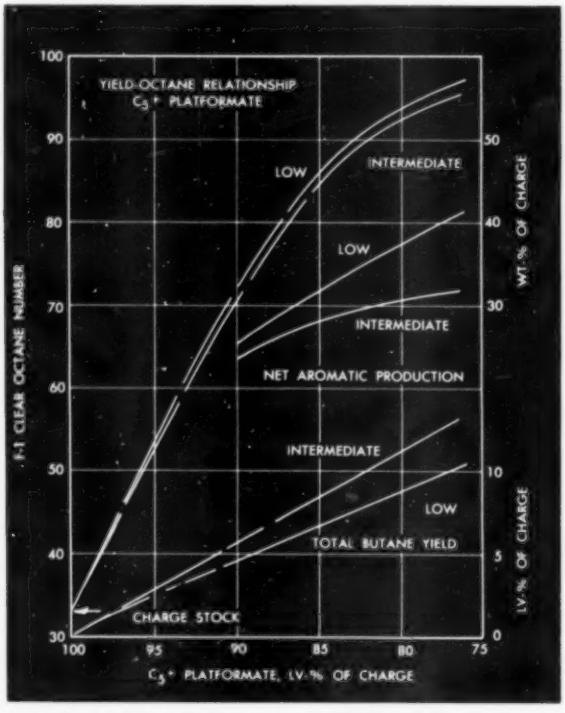


FIG. 2—Results of Platforming a high paraffin content straight-run Kuwait naphtha at intermediate and low pressures

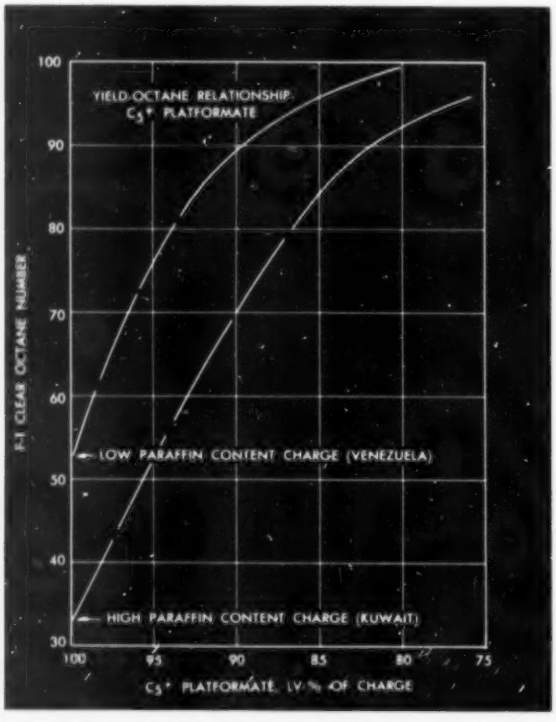


FIG. 3—Intermediate pressure Platforming of a low and a high paraffin content straight run naphtha

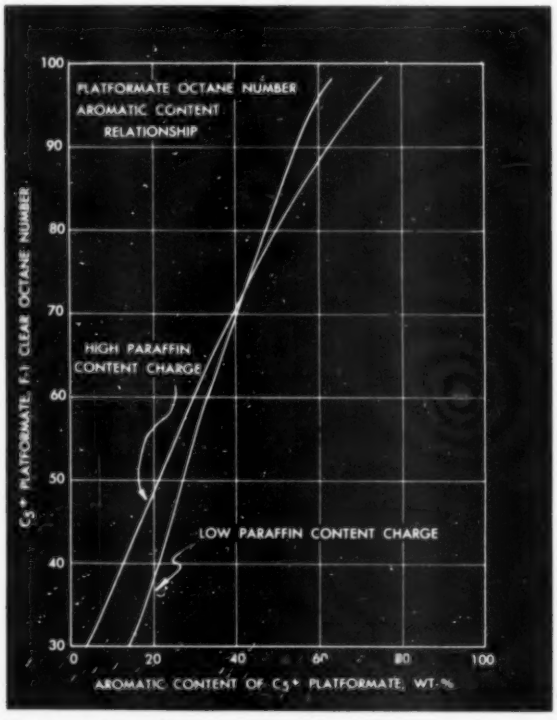


FIG. 4—Intermediate pressure Platforming of a low and high paraffin content straight run naphtha

low paraffin content charge, where the aromatics are produced from naphthenes. This is due in part to the greater extent of hydrocracking accompanying dehydrocyclization as compared to the conversion of the naphthenes to aromatics.

The C_1-C_3, C_4 and C_5 yields shown in Tables 2 and 3 (and in Figs. 1 and 2 in the case of the C_4 yields) show the greater amounts of light hydrocarbons formed while processing the high paraffin stock. Thus, the yield of C_5+ Platformate produced from the low paraffin content charge is considerably greater than in the case of the high paraffin content charge stock—for example, 85.7% vs. 77.2% at the 95 F-1 clear octane number level, as shown in Fig. 3. This difference in yield, however, can be attributed only in part to the greater amount of hydrocracking.

It should be kept in mind that there is a substantial difference in the initial octane number of the two charging stocks. As will be observed from Fig. 3, the Platforming of the high paraffin content stock results in a yield of 95% by volume at the initial octane number of the low paraffin stock. Adjusting the yields at 95 F-1 clear octane number for the difference in initial octane number, the recoveries corresponding to the same octane number increase are 85.7 and 81.3% by volume, respectively, for the low and high paraffin content stocks.

Furthermore, it should be noted that the dehydrocyclization reaction of paraffins to aromatics results in the removal of four hydrogen molecules as compared with the loss of three molecules of hydrogen during naphthene dehydrogenation, along with a greater density shift associated with the conversion of paraffins to aromatics as compared with the conversion of naphthenes to aromatics.

Thus, corrections based on the above factors would tend to reduce still further the observed yield differential. The main point of interest is, of course, the fact that the high paraffin content charge stock can be upgraded to the 95+ level, due to the high dehydrocyclization activity of the catalyst.

Fig. 4 relates the Platformate quality, as expressed by the F-1 clear octane number, with the aromatic content. It will be noted that the Platformate produced from the low paraffin content charge shows a considerably lower aromatic concentration at the same octane number. This indicates that the non-aromatic portion, which is mainly paraffinic, is of a better quality.

At first glance, it would appear that the greater extent of dehydrocyclization noted with the high paraffin content stock has the effect of removing a portion of the lower quality paraffins from the product. However, in previous work it has been established that paraffins readily undergo isomerization to equilibrium concentrations at Platforming conditions.[2] In the above two cases this would result in equivalent blending octane numbers for the paraffinic portion of the two Platformates. However, a larger part of the paraffins in the originally high paraffin stock has undergone hydrocracking to lower boiling paraffins. These paraffins have an appreciably higher octane number, thus imparting a higher blending octane value to the non-aromatic portion of the product from the originally high paraffin content stock.

Figs. 1 and 2 show the effect of pressure on the Platforming operation on these two types of charge stocks. Figs. 1 and 2 also indicate that the effect of pressure on the low and high paraffin content stocks is similar insofar as the yield-octane relationship is concerned.

In the case of the high paraffin content stock, the increased pressure suppresses the aromatic production to an increasingly greater extent at the higher conversion levels (Fig. 2), and results in a substantial increase in hydrocracking as shown by the C_4 production.

With the low paraffin content stock, however, the effect of a pressure increase on hydrocracking, as shown by the C_4 yield (Fig. 1) is quite small. The effect of increasing pressure on the Platforming of the low paraffin stock is that of suppressing aromatic formation to about the same extent throughout the conversion range studied.

Thus, it becomes apparent that the production of aromatics by dehydrocyclization of paraffins is more sensitive to pressure variations than the production of aromatics from naphthenes.

References

(1) Haensel, Vladimir, *Oil and Gas Journal*, 48, No. 47, 82 (1950).

(2) Haensel, Vladimir and Donaldson, G. R., *Industrial and Engineering Chemistry*, Vol. 43, p. 2102, Sept., 1951.

Table 4—Platforming of a High Paraffin Kuwait Content Straight-Run Naphtha—Intermediate Pressure

Severity	1	2	3	4
Yields:				
H_2, SCF/bbl. of charge	271	401	446	456
Dry Gas (C_1-C_3) (SCF/bbl. of charge)	186	193	276	329
C_4H_{10}, liq. vol. % of charge	8.3	9.0	9.0	13.2
C_5H_{12}, liq. vol. % of charge	9.4	9.1	11.3	12.0
C_5 + Platformate, liq. vol. % of charge	85.3	84.1	81.0	76.6
Properties of C_5 + Platformate:				
F-1 Clear Octane Number	83.6	86.2	91.2	95.2
F-1 + 3 cc. TEL Octane Number*	95.2	96.2	99.0	+.08 cc.
Aromatic Content, Wt. %	51.0	51.1	56.4	59.6
Vapor Pressure, psig.	3.1	3.1	3.7	4.1
Gravity, °API @ 60° F.	51.1	50.7	49.6	48.1
Specific Gravity @ 60° F.	.7749	.7766	.7813	.7879
Engler Distillation, ° F @:				
IBP	134	126	130	124
10%	186	180	174	160
50%	280	276	276	276
90%	343	339	339	336
95%	354	354	359	356
E.P.	406	410	424	414
Conversion Values:				
Aromatic Production, wt. % of charge	44.1	43.6	46.6	47.0
Net Aromatic Production, wt. % of charge	28.2	27.7	30.7	31.1
Net Aromatic Production, % of net theoretical arom. prod. from naphthene	142	140	155	157

* + cc. Denotes iso-octane + cc. of TEL/Gal.

Table 5—Platforming of a High Kuwait Content Straight-Run Naphtha—Low Pressure

Severity	1	2	3	4	5
Yields:					
H_2, SCF/bbl. of charge	531	566	666	726	796
Dry Gas (C_1-C_3) (SCF/bbl. of charge)	101	160	191	244	316
C_4H_{10}, liq. vol. % of charge	4.7	6.1	7.0	8.6	10.5
C_5H_{12}, liq. vol. % of charge	...	6.2	...	7.8	8.4
C_5 + Platformate, liq. vol. % of charge	90.0	86.7	84.2	80.7	76.0
Properties of C_5 + Platformate:					
F-1 Clear Octane Number	72.8	80.0	87.6	92.8	97.2
F-1 + 3cc. TEL Octane Number*	...	92.2	...	99.1	+.18 cc.
Aromatic Content, Wt. %	44.8	50.6	55.9	62.5	72.4
Vapor Pressure, psig.	...	...	...	2.7	3.2
Gravity, °API @ 60° F.	49.8	49.2	47.5	46.0	43.7
Specific Gravity @ 60° F.	.7805	.7831	....	.7972	.8076
Engler Distillation, ° F @:					
IBP	161	149	141	138	134
10%	241	216	209	197	186
50%	294	289	290	292	292
90%	346	346	347	346	344
95%	362	356	362	365	363
E.P.	394	400	406	418	424
Conversion Values:					
Aromatic Production, Wt. % of charge	41.2	45.0	48.6	52.5	57.6
Net Aromatic Production, Wt. % of charge	25.3	29.1	32.7	36.6	41.7
Net Aromatic Production, % of net theoretical arom. prod. from naphthenes	128	147	165	185	211

* + cc. Denotes iso-octane + cc. of TEL/Gal.

INDUSTRY MEN* on the refining sub-committee lay plans for . . .

The 1953 Petroleum Exposition

THINGS are already beginning to hum on the grounds of the International Petroleum Exposition in Tulsa in preparation for the 1953 show which starts May 14 and runs through May 23.

Exhibit space will be a third larger than before—26 acres this year. There will be more than 800 exhibitors, as against 526 in 1948. Value represented by the 1953 exhibits is estimated by IPE officials at about $100 million.

Considerably more emphasis on refining and petrochemistry is promised for this year's "Oil Show." About 40% of the commercial exhibitors have indicated their intention to show products and equipment useful to refineries and petrochemical plants. A subcommittee on refining of the Scientific and Technical Committee for the Hall of Science—one of the non-commercial buildings at the exposition—will be responsible for educational exhibits in the fields of refining and marketing.

Shown in the photograph above during the organizational meeting held at Tulsa are members Lee Haugen, vice president, refining, Cities Service Oil Co., Bartlesville, Okla.; G. E. Wynn, vice president, manufacturing, Mid-Continent Petroleum Corp., Tulsa; Luther Williams, Sunray Oil Corp., Tulsa, (representing H. W. Manley, vice president, manufacturing and sales); G. R. Kinter, vice president, manufacturing, Tide Water Associated Oil Co., Tulsa; C. D. Hull, manager, Ponca City, Okla., refinery, Continental Oil Co.; G. H. Westby, chairman, Scientific and Technical Committee, and president, Seismograph Service Corp., Tulsa; H. M. Smith, U. S. Bureau of Mines, Bartlesville; Dr. R. B. Weatherby, committee consultant, and vice president Amerada Petroleum Corp., Tulsa.

C. F. Niessen, sales promotion manager, Mid-Continent Petroleum Corp., Tulsa; C. C. Tate, manager, refining dept., Phillips Petroleum Co., Bartlesville; W. J. Carthaus, chairman of the refining subcommittee, and vice president, manufacturing, Deep Rock Oil Corp., Tulsa; H. H. Belew, assistant to vice president, manufacturing, Skelly Oil Co., Tulsa; and W. J. Fuchs, merchandising manager, Deep Rock Oil Corp., Tulsa.

Since the field of marketing is not represented by a special subcommittee this year, it is understood that some phases of the sales end of the petroleum industry will be included in the "refining" subcommittee's activities and exhibits.

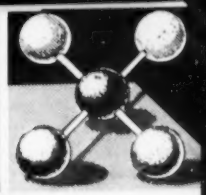
A petrochemical subcommittee, under the chairmanship of Dr. Miller Conn, Phillips Petroleum Co., Bartlesville, includes Dr. Isaac Drogin, research director, United Carbon Co., Charleston, W. Va.; Leroy Donald, sales manager, chemical sales division, Lion Oil Co., El Dorado, Ark.; James G. Park, vice president, Enjay Co., New York; and M. H. Keel, advertising manager, Shell Chemical Corp., New York.

In addition to these two groups, four other subcommittees are set up to be responsible—each for one-sixth of the Hall of Science space—for their own respective exhibits. They will cover geology, transportation, production, and drilling.

A housing bureau has been established under the direction of B. A. Meyers as chairman, and management of J. B. Marshall of the Tulsa Chamber of Commerce Convention Bureau. Because of the anticipated huge attendance—over 300,000 in 1948—hotel accommodations in Tulsa will be insufficient. The bureau has listed 1400 private homes for lease during the show, 75% of which have never before been available. Sleeping rooms in private homes have not yet been listed.

The bureau will handle all requests for reservations, both in hotels and in homes. Hotels will not make direct reservations. The bureau is charged with the entire responsibility for assignments. Information can be obtained from "IPE Housing Bureau, 616 So. Boston, Tulsa 3, Okla."

*Standing, L to R: Haugen, Wynn, Williams, Kinter, Hull, Westby, Smith, Weatherby. Seated, L to R: Niessen, Tate, Carthaus, Belew, Fuchs.



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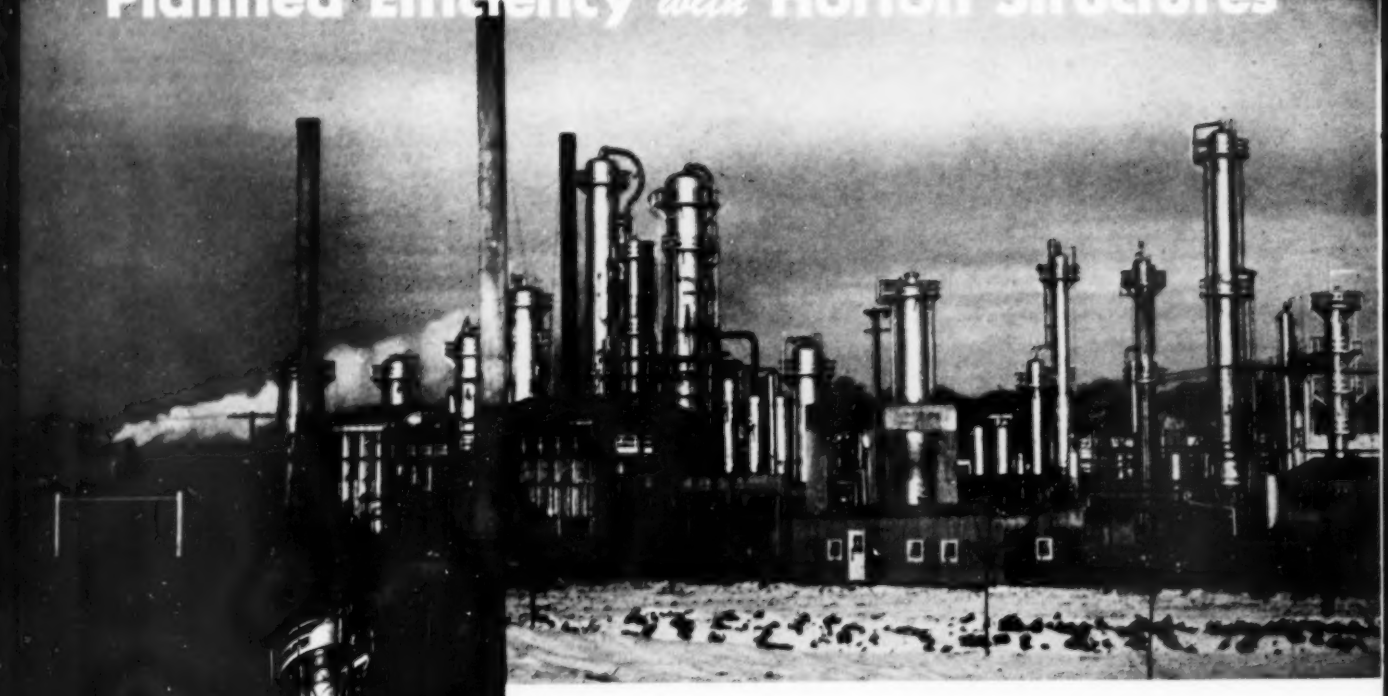
Petrochemical Processing Section

Planned Efficiency *with* Horton Structures



A large number of Horton structures—cone roof storage tanks, a Horton Vaporsphere, refinery towers, and pressure vessels—have been installed at the midwest refinery shown in the view above and at the left. They provide dependable storage facilities and efficient processing units that help obtain the highest practical yield from every barrel of crude. Each of these structures were designed for superior performance. Careful fabrication, erection, and inspection assures this result.

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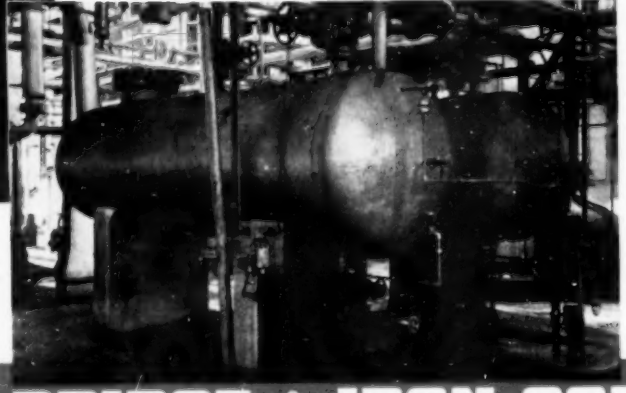
Above: A 3-ft. 6-in. by 39-ft. absorber tower (extreme left) and a 5-ft. by 90-ft. 8-in. catalytic gasoline debutanizer built for Rock Island Refining Corp.



Left: 4-ft. diam. by 18-ft. debutanizer relief drum and 4-ft. by 16-ft. water settler tank built for Rock Island Refining Corporation.

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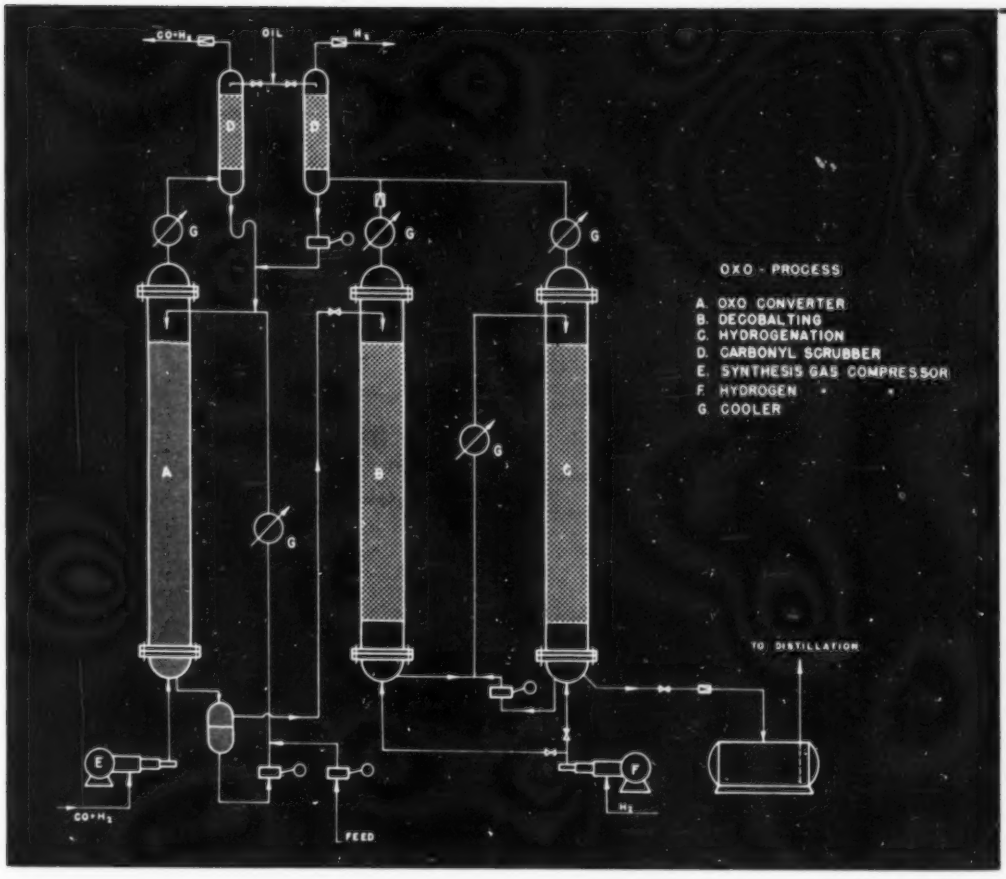


Courtesy Blaw-Knox Co.

AN AMERICAN VERSION of the Oxo process

The Oxo Process in the U.S.

. . . for petrochemicals from olefins

By PETER W. SHERWOOD
Chemical Engineer, New York

IN THREE short years, the American petrochemical industries have turned the Oxo process—the hydroformylation of olefins—into a truly large-scale operation. As recently as 1949, Esso Standard Oil Co. took the first Oxo unit on stream at Baton Rouge. Since that time, four other producers have entered this field actively, and at least three other firms have made exploratory moves in its direction.

Most recent entrant into the field is Gulf Oil Corp. which, at this writing, has a plant under construction at its Port Arthur refinery. Principal product will be iso-octyl alcohol, a chemical of growing importance as raw material for the manufacture of plasticizers. Other manufacturers of iso-octyl alcohol, who have selected the Oxo route, are Esso Standard Oil Co., and Standard Oil Co. (Indiana), which is now constructing the necessary facilities (rated at a reported 10 million lbs./yr. capacity) at Wood River, Ill.

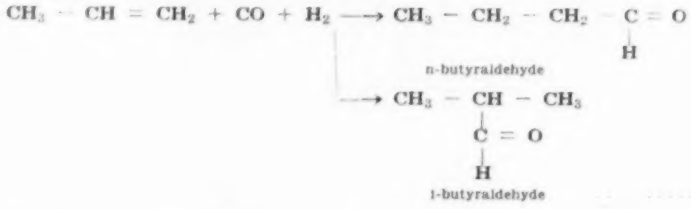
Illustrating the versatility of the Oxo reaction is the Tennessee Eastman installation at Longview, Texas, where propylene is reacted with carbon monoxide and hydrogen to yield butyraldehyde. This plant has been on stream since early 1952. The same synthesis was studied on a pilot-plant scale by Rohm and Haas Co, although in this instance, commercial operation was not undertaken.

At its Belle, W. Va. plant, DuPont has employed oxoation for the production of trimethyl hexanol from di-isobutylene. According to recent reports, this operation has, however, been discontinued.

This new unit process, the Oxo synthesis, involves the simultaneous reaction of carbon monoxide and hydrogen (synthesis gas) with an olefin to yield an aldehyde containing one more carbon atom than the hydrocarbon feedstock. The synthesis is typified by the reactions shown in Fig. 1, which are or have been in commercial use in the United States. In all of the reactions, a number of by-product isomers are formed in accordance with factors to be outlined below.

PRODUCTION OF BUTYRALDEHYDE

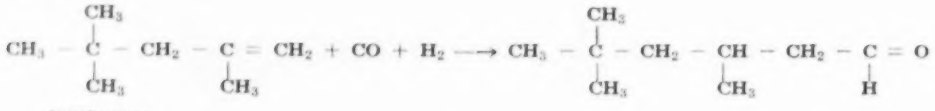
(Tennessee Eastman Corp.)



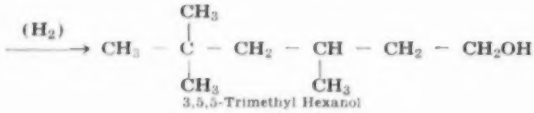
(1)

PRODUCTION OF TRIMETHYL HEXANOL

(du Pont)



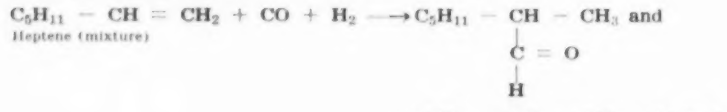
(2a)

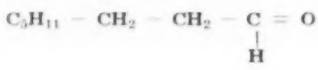


(2b)

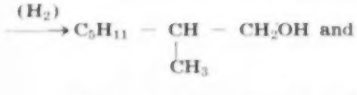
PRODUCTION OF ISO-OCTYL ALCOHOL

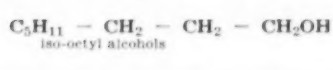
(Standard Oil of Indiana, Esso Standard Oil, and Gulf Oil)





(3a)





(3b)

FIG. 1—Typical reactions for the OXO process which are or have been in commercial use in the United States

It is seen that American commercial interest in the Oxo reaction has, so far, been confined to the production of chemicals of fairly well-defined structure and of relatively low molecular weight. This is, of course, primarily due to the demands of the market. It is worth noting that the first commercial installation (at Oberhausen, Germany) was intended for the production of fatty alcohols in $C_{10}-C_{20}$ range for ultimate use in alcohol sulfate type detergents. The design raw material for this installation is a suitable fraction of Fischer-Tropsch product.

Background of the Oxo Process

The origins of the Oxo process go back to 1930 when Smith and coworkers[1] passed ethylene, carbon monoxide and hydrogen over a cobalt catalyst in the course of a study of the behavior of olefins under Fischer-Tropsch conditions at atmospheric pressure. The formation of oxygenated chemicals in small yields was noted, but the significance of the discovery was evidently not realized.

It was not until 1939 that Roelen and others at Germany's Ruhrchemie undertook an extensive investigation of this reaction. One of their most significant contributions was the discovery that the production of Fischer-Tropsch hydrocarbons could be almost completely suppressed, and the yield of oxygenated chemicals correspondingly boosted by operating at pressures in excess of 1500 psig. and at temperatures below 200° C.

This work resulted in a number of patent applications. The process was further developed by joint efforts with I. G. Farbenindustrie. At the end of the war, the Technical Oil Mission and other investigative organizations of the Allied governments found in existence one commercial Oxo installation at Oberhausen which had, however, never been operated. The unit was designed for batch-wise operation. Another Oxo plant, for the production of propionaldehyde from ethylene and synthesis gas by a continuous slurry process had been completely designed for the Italian firm of Bombrini-Parodi-Delfino.

Since 1946, the process has been the subject of intensive investigative efforts in this country and abroad. In addition to the companies referred to above, Shell Chemical Co., Oronite Chemical Co., and The Texas Co., have expanded considerable research on oxoation. At least one chemical construction firm (Blaw-Knox Co.) offers specialized design experience.

The great attraction of the Oxo

reaction rests in its remarkable versatility. It takes place with a host of olefinic and acetylenic compounds. In the laboratory, olefins ranging from ethylene to diisobutylene, from cyclohexane to pinene, and from ethyl acrylate to styrene, have been successfully subjected to the Oxo reaction, often with yields in excess of 90%. The process offers the only known route of economic potential for the commercial production of a whole gamut of aldehydes, acids, alcohols, and their derivatives.

There are certain limitations to the scope of the Oxo process. It is, for instance, not yet possible to effect the reaction with aromatics* (note, however, that the Bureau of Mines has recently succeeded in producing tetrahydrofurfuryl alcohol by the reaction of synthesis gas with furan). The oxoation of dienes takes place with only very unsatisfactory yields of the expected dialdehyde. In the latter case it is found that the principal product is the monoaldehyde, indicating that only one of the olefinic bonds is susceptible to the reaction.

Propionaldehyde and n-propanol initiate the series of compounds which can be produced by the Oxo process. An unusual aspect of this synthesis, which is peculiar to the oxoation of ethylene, is the simultaneous formation of a ketone (in this case, diethyl ketone) in appreciable amounts[2]. The production of n-propionaldehyde may someday play an important part in the manufacture of trimethylol ethane, a substitute for pentaerythritol in some of its applications[3].

Next in the series is the production of butyraldehyde from propylene. The formation of n- and i-butyraldehyde has been reported in the approximate ratio 3:2 by Cook[2]. The distribution of isomeric aldehydes is, however, subject to some adjustment, and Nienburg[5] has reported almost equal yields of n- and i-butyraldehyde in the oxidation of propylene.

The fact that the Oxo synthesis has been made the basis of butyraldehyde production at Tennessee Eastman's Longview plant is indication that it has been developed to the point where it can compete effectively with the traditional process for the synthesis of butyraldehyde from acetaldehyde via crotonaldehyde.

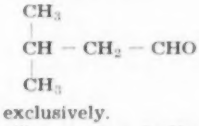
As the length of the hydrocarbon chain increases, the number of possible Oxo derivatives multiplies rapidly. In addition to the normal addition of the carbonyl group to either side of the olefinic bond, very considerable isomerization of the double bond is encountered at the conditions of the Oxo reaction. Keulemans and coworkers[4] have shown that, in the case of olefins containing the double bond in other than terminal position, the products derived in the course of Oxo synthesis are almost identical with those obtained from the isomeric olefin having its double bond at the end of the chain. The oxoation (and subsequent hydrogenation) of pentenes led to the following distribution of products:

Product	Pentene-1	Pentene-2
2-ethyl butanol-1	6%	10%
2-methyl pentanol-1	46%	46%
n-hexanol	48%	44%

The same observation has also been demonstrated for branched-chain olefins.

The following rules of addition have been formulated for the Oxo reaction:

1. Due to steric hindrance, the formyl group will not add to a tertiary carbon atom to form a quaternary carbon atom. For example, the hydroformylation of isobutylene yields isovaleraldehyde



almost exclusively.

2. In the event a tertiary carbon atom occurs at both ends of the double bond, reaction takes place only after isomerization of the double bond to a position in which hydroformylation in accordance with Rule 1 is possible.

3. Olefins will undergo isomerization under Oxo conditions, even if they are thermodynamically the more stable form. The product mixture depends on the relative reaction rates of isomerization and oxoation. Quite frequently the less stable (i.e. terminal) isomer will react more rapidly than the more stable olefin.

Unless other effects of steric hindrance, etc. interfere, it may be stated as a rough rule, that the aldehydeic product is 60% branched-chain and 40% straight-chain (predominantly derivative of terminal-position olefins).

Complexities of the Product

It has been shown that the Oxo reaction leads to a complex mixture of isomeric aldehydes and primary alcohols. In addition, a number of side reactions takes place during the Oxo stage to form esters (by the Cannizzaro reaction), ketones (by the condensation of two molecules), and polymerization products. By the choice of proper operating conditions, these side reactions can, however, be minimized and yields of primary alcohols (after hydrogenation of the oxo mixture) can be realized in the range of 70-90% of theory.

In order to facilitate product purification, it is universally necessary to start with a pure olefinic stock. In spite of this precaution, the end product must be thoroughly fractionated. However, aldehydes above C_5 would have to be subjected to such drastic conditions of distillation that large amounts of the reactive aldehydes are converted to esters (by disproportionation), aldols (by condensation), and other undesired by products. The yield of aldehydes eventually becomes so low that recovery by this method becomes prohibitive.

In work done to date with higher olefins, it has therefore been common practice to convert the primary products directly to more stable compounds before separation. The most frequent means selected is the hydrogenation to alcohols which can be more readily purified. The isolated alcohols can be subsequently oxidized to the desired aldehyde. Alternate means include direct oxidation of the Oxo aldehydes to the corresponding acid.

No such stringent precautions are necessary in the production of low-boiling aldehydes. Propionaldehyde can be readily purified by fractionation. Not much greater difficulties are encountered in the production of butyraldehyde. The two isomers n-butyraldehyde and i-butyraldehyde exhibit a sufficiently low boiling point and large boiling point spread (B.pt.74.7° and 61° C., resp. at atmospheric pressure) to permit adequate separation by distillation.

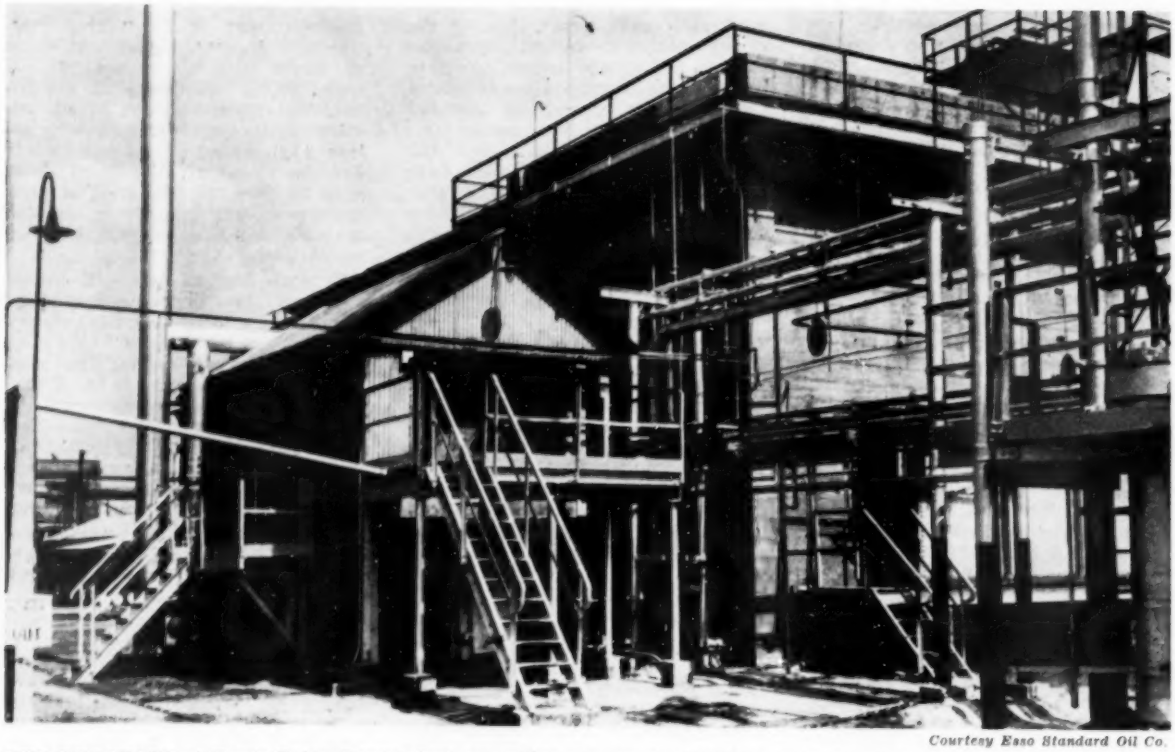
Valeraldehydes are the last in the series of Oxo aldehydes which can be freely separated from the primary product. Aldehydes formed by the Oxo reaction with pentene or higher olefins are subject to the limitations of recovery which have been outlined above. By present processing methods, it is doubtful whether these aldehydes can be directly synthesized in pure form by the Oxo reaction. Here the main importance of the process rests in the manufacture of aldehyde mixtures, either for direct sales—if outlets can be developed—or as intermediates in the production of the corresponding alcohols. (The commercial synthesis of octanols and nonanols from heptene fractions and diisobutylene, respectively, has been referred to above.)

Oxo Reaction Conditions

Insofar as this writer has been able to determine, the Oxo reaction is carried out in the liquid phase in every commercial instance. The controlling variables are catalyst, operating pressure and temperature and, to a more limited extent, the suspension medium.

1—Catalyst: An active form of cobalt is universally employed in the Oxo reaction. The work of Adkins[6] indicates that the active principle of the Oxo catalyst is cobalt hydrocarbonyl. The conclusion that either this compound or dicobalt octacarbonyl are the effective Oxo catalysts has

*The Oxo reaction involves the addition of a carbonyl group and a hydrogen atom to a double bond. It must be distinguished from the Gatterman-Koch synthesis which involves the substitution of a carbonyl group in an aromatic nucleus.



Courtesy Esso Standard Oil Co.

OXO REACTORS at Esso's Baton Rouge plant are within a concrete enclosure used formerly for high pressure hydrogenation

been suggested since the early days of the synthesis. Quantitative support is lent to this theory by Wenner's recent work,[7] according to which almost complete conversion of ethylene and propylene to their Oxo aldehydes is thermodynamically possible at atmospheric pressure. Since the Oxo reaction has never been carried out successfully at pressures substantially below 50 atmospheres, this may be related to the high partial pressure of carbon monoxide which is required for the formation of cobalt carbonyls.

For operation at low temperatures (and consequently lower permissible pressures), the use of cobalt in some highly active form is desirable. The use of Raney cobalt and preformed dicobalt octacarbonyl has been mentioned in this connection[8] but commercial utilization of these forms of the catalyst is economically not feasible. The Ruhrchemie version of the process employed standard Fisher-Tropsch cobalt catalyst, suspended in the reaction slurry.

This catalyst contains 30% cobalt, 2% thoria, 2% magnesia, and 66% kieselguhr. It was selected in German practice because it is a highly active form of cobalt which was available at Fischer-Tropsch plants. There is some evidence, however, that the presence of magnesia is objectionable because of its tendency to promote the condensation of the product aldehydes.

In the absence of sulfur compounds, this catalyst will result in the formation of a product containing some 20-40% alcohols. The same catalyst may be subsequently used for the complete hydrogenation of the make. Where the formation of aldehydes rather than of alcohols is the desired objective, the addition of a small amount of sulfur has proved useful. This is without significant effect on the progress of the Oxo reaction but it suppresses alcohol formation almost completely.

While Ruhrchemie employed this catalyst in a batch-type basis, I. G. Farbenindustrie at Leuna was able to develop a continuous process in which the same catalyst was employed. This process showed good space velocities and was deemed the most promising approach to the industrial exploitation of the Oxo process. This is the basic approach which has also been selected for a least one American installation.

A fixed-bed catalyst was employed in a pilot plant operated at Ludwigshafen. Because some cobalt is continuously removed in the form of its volatile carbonyl, it is necessary to replace it by the addition of cobalt to the feed. At this particular installation, this requirement was met by the addition of the cobalt salt of a fatty acid to the olefinic feedstock.

Another fixed-bed Oxo process, which was studied at Leuna, involves the use of a copper-modified cobalt catalyst. It was found that copper has a stabilizing effect on cobalt and will thus reduce its volatilization in the form of the carbonyl. The catalyst is suitable only for the Oxo stage and is not satisfactory for hydrogenation purposes. Its conversion capacity is small.

The patent literature indicates that American research has followed both basic lines—fixed bed and slurry-type catalysis of the Oxo process. Miscellaneous formulations (e.g. silica hydrogel, impregnated with cobalt, copper, and thorium) have been recommended for their particularly high degree of activity[9]. Some patents have also claimed activity for iron and nickel catalysts. Limited usefulness of iron for the Oxo synthesis has been demonstrated[10] but the claim[11] for the usefulness of nickel in this reaction is contrary to much evidence reported elsewhere and will have to be more firmly established.

2—Effect of Temperature: Operation at low temperatures has the advantage of permitting reduction in system pressure. The required temperature level is, to a certain extent, dependent on the olefin feedstock and on the activity of the cobalt catalyst. In general, Oxo temperatures are in the range, 120-145° C. To operate effectively in this low temperature range, active forms of cobalt, such as those described, must be employed. With this type of catalyst, oxoation of normally liquid olefins has been

reported at temperatures as low as 45-65° C.[13]. However, reaction rates at this level are unsatisfactory.

At temperatures in the range of 150-190° C., almost any cobalt salt (such as the acetate, oxide, etc.) can be used as Oxo catalyst. Here, the optimum temperature depends on the ease with which the cobalt salt is converted to the active catalyst (cobalt hydrocarbonyl or dicobalt octacarbonyl[14]). An accompanying phenomenon of operation at higher temperatures with Fischer-Tropsch cobalt catalyst is the increasing formation of alcohols in the primary Oxo stage of the process.

The required temperature is influenced by the structure as well as by the length of the olefinic charge. Higher temperatures are needed for the Oxo conversion of highly branched hydrocarbons. Furthermore, short-chain olefins which are not subject to double-bond isomerization are oxoated at somewhat higher temperatures with consequent improvement in conversion. This is not feasible if the production of aldehydes is the ultimate objective since formation of alcohols increases as the operating temperature is raised.

In the oxoation of the higher olefins, it is especially desirable to operate at the lowest practicable temperature because the tendency toward double-bond isomerization is more pronounced at elevated temperatures while the Oxo reaction is not markedly affected by raising the temperature above a certain minimum. The effect of this accelerated isomerization makes itself felt also in the composition of the product. It has been found, for instance, that the alcohols produced from a C_{10} fraction at 170-190° C. have a low melting point. A product of considerably higher melting point is obtained by holding the primary Oxo conversion temperature between 100 and 130° C.

By the standards of the Fischer-Tropsch process, to which the Oxo reaction is related, synthesis is not particularly temperature-sensitive. It is therefore possible to maintain the temperature differential between coolant and reaction phase as large as 20° C. This is about ten times greater than the permissible temperature drop in Fischer-Tropsch operations with cobalt catalyst. This is of great significance in the light of the large heat evolution which accompanies the Oxo synthesis. In the course of reaction about 50,000 B.t.u. are evolved per lb.-mole olefin converted. In the case of the lower olefins, this value rises up to a maximum of 62,500 B.t.u./lb.-mole for ethylene.

3—Effect of Pressure: While the oxo reaction can theoretically proceed at atmospheric pressure, the need to prevent decomposition of the catalyst, dicobalt octacarbonyl, calls for partial pressures of carbon monoxide in excess of 40 atmospheres (at 150° C.). Accordingly, the oxo reaction is generally run at system pressures in the range of 100-250 atmospheres.

Natta and Beati[15] have shown that the rate of oxoation is independent of pressure above 75 atmospheres. This finding is not confirmed in experimental continuous operations carried out at Ruhrchemie. In these laboratory runs, the following effective conversion was reported as a function of pressure. Contact time was 1 hr., CO/H_2 ratio was 1.

Pressure (atm)	Approximate Conversion (%)
50	10
100	50
150	70–80
275	95

Orchin and Schroeder[14] ascribe the discrepancy between these two sets of experimental findings to poor contact between synthesis gas and reaction phase under the continuous operating conditions at Ruhrchemie. This limitation is expected to impose a minimum requirement of 125-150 atmospheres for oxoation in continuous flow.

4—Effect of Miscellaneous Operating Variables: Synthesis gas employed for the Oxo reaction is generally composed of equal volume parts of carbon monoxide and hydrogen; i.e. the theoretical ratio is employed. Higher hydrogen ratios tend to increase the amount of hydrogenation, while a synthesis gas rich in carbon monoxide favors isomerization of the double bond position. In the vicinity of a 1:1 carbon monoxide to hydrogen ratio, the exact composition of gas does not appear to be too critical. In the oxoation of gaseous olefins, the hydrocarbon is introduced with the synthesis gas in approximately theoretical ratio.

Operation in a liquid phase, even for the production of propionaldehyde and butyraldehyde, permits a ready solution to the problem of heat removal and reduces the extent of catalyst fouling and decomposition. Where liquid olefins are to be oxoated, the feedstock itself is used as suspension medium. Complete olefin conversion is generally taken in a single pass. Synthesis gas, on the other hand, is introduced in excess (where liquid olefins are the raw material) and must be recycled.

In the Oxo synthesis with gaseous olefins, an auxiliary suspension medium must be employed. Usually an inert hydrocarbon is selected which differs in boiling point sufficiently from the resulting aldehyde to permit ready separation. In laboratory work, cetane has been used to good advantage. The Bombrini propionaldehyde process was designed for the use of toluene as solvent. Operation in an aqueous phase at higher temperatures (200° C. vs. 100° C. in toluene) was also considered and is reported to have a definitely favorable effect on the propionaldehyde yield, possibly due the prevention of aldol condensation. The use of aqueous suspension has the disadvantage of requiring the recovery of the aldehyde from a very dilute aqueous solution.

A similar beneficial effect of water on overall Oxo yield has been reported for higher olefins[12]. However, the presence of water in the product introduces great difficulties in the purification step because of the formation of a variety of azeotropes.

The concentration of catalyst in the slurry varies from 0.04-0.05% cobalt (based on the weight of olefin) where cobalt carbonyl is added as such, to 3 wt.-% for the case of Fischer-Tropsch cobalt catalyst. Use of larger concentrations of catalyst, coupled with operation at higher temperatures has been recommended for the single-stage production of Oxo *alcohols*[8].

Process Aspects of OXO Synthesis

Except for the production of the lower aldehydes, the Oxo process must be carried out in a minimum of two chemical steps. Hydroformylation (i.e. the Oxo reaction proper) takes place in the primary stage. As we have seen above, some alcohol formation occurs in this step. Separation of the primary make is highly yield-consuming because of the low stability of aldehydes at fractionation temperatures. Furthermore, up to 20% of the crude primary product contains aldehydic condensation products which are not recoverable as such.

These difficulties can be overcome by subjecting the primary Oxo product to a secondary hydrogenation step. Objective of this operation is to convert the Oxo aldehydes into the corresponding alcohols which are characterized by much higher stability and permit separation by economically feasible physical methods. In addition, it has been found that about one-half of the polymerisate formed in the Oxo step reverts to the simple monomeric alcohol upon hydrogenation. I.e., the yield of alcohols from the second step actually exceeds the aldehyde content of the feed.

Thus, a hydrogenation step must be employed even if the higher aldehyde is the desired final product (note that this is not now the case in any commercial installation; butyraldehyde is the only Oxo aldehyde on the market and its purification

does not offer the problems outlined above for its higher homologues). Once isolated in the desired degree of purity, Oxo alcohol can be readily reoxidized to the corresponding carbonyl compound.

It is not feasible to carry out the Oxo and hydrogenation steps in a single stage. The high carbon monoxide content required for successful execution of the hydroformylation reaction interferes with the hydrogenation reaction. Indeed, to effect complete alcohol formation, it is necessary to keep the carbon monoxide content of the system at very low values. Suitable means to bring this about will be discussed later.

In this connection, attention is called to some interesting recent work by Wender et al.[16], in which aldehydes (e.g., butyraldehyde) are reduced to the corresponding alcohols in the presence of *water gas* by the use of cobalt catalyst at considerably higher temperatures (around 180° C) than are customarily employed for oxoation. This opens up the possibility of an eventual one-step process, or at least of a simplified two-stage process in which the two stages differ only in temperature level and not in the composition of the reaction gases.

Today, the Oxo process is apparently universally carried out on a continuous basis. The first Oxo plant, at Ruhrchemie, was set up on a batch basis, but even here it was readily shown that conversion to a continuous slurry process would raise throughput per unit reactor volume five-fold.

The following process description will apply to the conversion of higher olefins (C_5 and above). The feasibility of applying the system to the production of lower aldehydes, by the use of an auxiliary liquid medium, and the possibility of producing lower aldehydes in a single stage, have been discussed above.

Slurry-type Process

The charge stock is mixed with the required quantity of cobalt-base catalyst. In the case of a catalyst akin to the Fischer-Tropsch composition, the proper weight range is 3-5%. Most of this catalyst mass is recycle material; make-up requirements are small.

The slurry is boosted to reaction temperature and pressure (150° C., 225 atmospheres) and is fed to the bottom of a primary reactor which it enters concurrently with a stream of synthesis gas with carbon monoxide:hydrogen ratio of 1.0. About two-thirds of the gas is a recycle stream, the remainder being make-up. To be sure, this ratio is quite variable and influences the reactor design significantly. The gas stream acts as a heat carrier and is capable of removing an appreciable portion of the total heat of reaction. It will thus reduce the cooling surface requirements within the reactor. Beyond this, the agitating action of the feed gas is of significant influence on the speed of conversion. The actual gas recycle ratio is selected by economic compromise.

About 70% conversion takes place in the first reactor. The reaction is taken to completion in a secondary Oxo converter. This separation into two (and even three) successive reactor chambers reduces the extent of intermingling between product and feedstock. Furthermore, the final stages of the reaction can be speeded up by operating the second reactors some 10-20° C. above the reaction temperature of the first unit. It is to be noted that operation at this higher temperature also boosts the amount of alcohols formed in the Oxo stage. Additional amounts of synthesis gas are fed to the bottom of the second reactor which is also operated in concurrent fashion.

Total contact time is of the order of 20-30 minutes. About one-third of the total reaction takes place during the first two minutes, and it is at this stage that cooling requirements are the most critical. In addition to the cooling action of the gas, indirect heat removal must be effected, either by the use of cooling tubes in the (primary) Oxo reactor or by external heat exchangers. The use of carbon steel is satisfactory for reactor construction.

The reactor effluent leaving the top of the second Oxo reactor is separated from the gas phase in a knock-out drum. With the exception of a small bleed stream, required to prevent the build-up of inerts, the gas is recycled to the reactor system via a gas cooler. The gas stream contains some sublimed cobalt carbonyl and precautions must be taken to prevent its deposition on the heat exchange surfaces. At reaction pressures (200-225 atmospheres), this can be achieved in the main by keeping gas temperatures above 50° C. Any incrustation formed can be removed from the surfaces by the injection of product alcohol.

The crude Oxo make is released to atmospheric pressure before it is fed to the hydrogenation stage. This venting is necessary to strip the slurry of contained carbon monoxide and to remove or break up the major portion of contained cobalt carbonyl. These materials would act as poisons in the hydrogenation stage (if Fischer-Tropsch catalyst is employed in this function).

The evolved gases are stripped with product alcohol to prevent loss of liquid by entrainment and of catalyst. The vented gases are small in volume and may be purged to the atmosphere.

Several catalysts are suitable for the hydrogenation step. If the olefinic feedstock is sulfur-free, the use of the Oxo catalyst itself is feasible. Alternately, a standard hydrogenation catalyst, such as copper chromite, may be employed after the removal of the cobalt compounds from the slurry. The presence of sulfur compounds in the charging stock necessitates the use of a sulfur-resistant catalyst, such as nickel tungsten sulfide, for the hydrogenation stage.

The use of hydrogenation catalysts other than that employed for the Oxo stage calls for the introduction of an intermediate partial hydrogenation step following the Oxo stage. By this operation, partially soluble cobalt carbonyl is reverted to the metallic state, and its subsequent removal is thereby made possible by filtration or by deposition on a suitable carrier in the decobalting reactor itself.

The slurry technique of hydrogenation in the presence of cobalt catalyst parallels the Oxo flow described above. The preheated feed slurry (i.e., the stripped crude product from the primary stage) is introduced at the bottom of the first hydrogenation reactor at a pressure of 200-250 atmospheres. Here it is joined by a stream of high-pressure hydrogen. Operation is at 170-180° C. The make from this converter overflows to the bottom of the second hydrogenation reactor, where it is joined by additional hydrogen. The product slurry is separated from the gas phase in a knock-out drum (or at the top of the reactor itself).

Hydrogen is charged to the first reactor at approximately 1.5-2.0 moles/mole of aldehydic feedstock, and an equal amount is fed to the second converter. About three-quarters of this stream must be recycled to the reaction stage. The crude recycle gases, as recovered in the knock-out drum, contain carbon monoxide which is derived mainly from the decomposition of cobalt carbonyl. It is necessary to suppress the build-up of this gas, which influences the progress of hydrogenation adversely. A favored method for its removal is to pass the crude recovered hydrogen over a methanization catalyst. An iron-based Fischer-Tropsch catalyst, operated at 250° C, brings about the desired methanization almost quantitatively.

The principal objection to the presence of methane in the recycle gas is its depressing effect on the partial pressure of hydrogen. Its build-up must therefore be limited to a sensible concentration (approximate maximum = 10%) by providing a bleed stream.

The crude slurry leaving the knock-out pot must be freed of suspended catalyst by filtration. Ceramic filter media have been used to advantage in this operation. The alcohols must

be separated from hydrocarbons, and frequently from each other, by distillation methods. This presupposes that a fairly pure olefinic feedstock has been employed. The Oxo conversion of wide fractions of olefins leads to highly complex mixtures which defy separation by economic means.

Fixed-Bed Processes

Use of a suitable fixed-bed Oxo process offers the advantages of eliminating the catalyst filtration step and some solids handling. Proper means must be provided to overcome difficulties due to the large heat evolution and the deterioration of the catalyst caused by the formation of soluble and volatile cobalt carbonyl.

One approach, which has attracted attention, is the Reppe system, originally developed at Ludwigshafen. The fundamental catalyst is cobalt carbonyl formed in situ during the progress of the reaction over a fixed-bed catalyst, consisting of metallic cobalt on a pumice carrier. The initial cobalt content is 2%.

To make up cobalt losses, this metal is introduced with the olefinic feedstock in the form of the salt of a fatty acid. This salt is originally formed by decomposing cobalt acetate in the presence of the fatty acid, and removing the resulting acetic acid in vacuo. The resulting cobalt salt is soluble in Oxo alcohol and its alcoholic solution is mixed with the hydrocarbon charge.

The olefinic charge, together with synthesis gas ($CO/H_2 = 1.0$) is fed to the top of the Oxo reactor (one to three units may be used in series as in the slurry process). A considerable excess of gas is employed, partly to act as heat carrier and partly to ensure complete conversion of the hydrocarbon stock. Most of this excess gas is recycled to the Oxo reaction stage.

The liquid effluent from the Oxo converters is separated from the gas phase and is fed to a partial hydrogenation (decobalting) converter for the destruction of dissolved cobalt carbonyl. This unit is filled with pumice on which the metallic cobalt deposits as it is formed. The treatment is carried out in the presence of hydrogen at 200 atmospheres and at approximately 120° C.

The carrier is permitted to build up a cobalt content of not more than 10% and must be regenerated periodically. This may be brought about by passing high-pressure carbon monoxide through the converter. The resulting cobalt carbonyl may be recovered and utilized in the Oxo stage. Other means for the removal of deposited cobalt have been suggested (e.g., treatment with nitric acid).

A recent American patent proposes the use of the Oxo converter and the decobalting unit in tandem fashion. This scheme calls for two identical converter systems and for cyclical operation. In the first phase of the cycle, the Oxo synthesis is carried out in converter system I. A fixed-bed catalyst, consisting of cobalt on a pumice carrier is employed, but no make-up cobalt is provided with the feed. In the course of the reaction, the formation of cobalt carbonyl results in cobalt depletion of the catalyst.

Reactor system II serves, during this phase of the cycle, to recover cobalt by deposition on a pumice carrier, in a manner similar to that described above. Eventually, the point is reached where cobalt depletion in the Oxo converters will no longer permit satisfactory execution of the synthesis. At this point, the two reactor systems are switched. Reactor system II now serves for the Oxo conversion, utilizing the cobalt which has been deposited in its catalyst mass during partial hydrogenation in the first part of the cycle. The catalytic strength of Reactor system I is built up during this stage by using these converters for decobalting purposes.

This scheme is subject to the difficulties inherent in cyclical operation of pressure reactions and troubles may arise from non-uniform catalyst composition. The eventual development of a continuous system based on this general idea (and using moving catalyst bed) may prove useful.

Fixed-bed Oxo processes do not permit the use of primary catalyst for the hydrogenation stage. The catalytic activity of cobalt carbonyl in hydrogenation reactions is negligible and another system must be employed (note that the active principle in slurry-type hydrogenation, described above, is metallic cobalt in special form). One consequence of the inability of cobalt carbonyl to serve for hydrogenation purposes is the very low alcohol content of crude Oxo product formed in the presence of fixed-bed catalysts.

The use of copper chromite for the hydrogenation stage has the great advantage over Fischer-Tropsch catalyst that the presence of reasonably small amounts of carbon monoxide do not interfere with the conversion of aldehydes to alcohols. The presence of sulfur compounds must, however, be rigorously excluded. The reaction may be carried out at 150 atmospheres and 150-180° C.

Markets for Major OXO Chemicals

The Oxo synthesis is still in its early stages of commercial development. Some important new markets have already been tapped for its products, especially in the case of octyl and nonyl alcohols. Other important outlets for Oxo-type chemicals have been previously developed to absorb the production of these compounds by other processes. Here, the Oxo synthesis offers a route which can prove competitively superior to established methods in many instances.

As yet, however, the vast potentialities of the Oxo synthesis are almost untapped for the production of wholly new chemicals of commerce. Even for so simple a compound as propionaldehyde, the Oxo process may well turn out to be the key for large-scale production. The potentialities of Oxo derivatives of cyclohexene, styrene, etc. cannot yet even be visualized. In such instances, considerable market development will have to precede commercial exploitation.

Propionaldehyde and n-Propanol

These are the simplest chemicals which can be produced by the Oxo synthesis. They are not, at this time, being produced commercially by this route, however. *N*-propanol can be prepared by the hydrogenation of propylene oxide, and a simple oxidation step will convert the primary alcohol to propionaldehyde. Another competitive source of these chemicals is the iron-catalyzed Fischer-Tropsch synthesis which serves for the production of synthetic gasoline at the Brownsville plant of Carthage Hydrocol Company. In this process, significant amounts of the lower straight-chain alcohols and aldehydes are formed as recoverable byproducts.

At present, the principal use for *n-propanol* is as solvent for waxes, resins and cellulose esters. It can also serve as intermediate in a number of syntheses. *Propionaldehyde* finds application as disinfectant and in the production of rubber accelerators. A derivative of potential significance is trimethylol ethane which can serve as substitute for pentaerythritol in the production of alkyd resins. The compound is formed by condensation of propionaldehyde with formaldehyde in accordance with equation[4]:

$$CH_3CH_2CHO + 2\,HCHO \rightarrow CH_3-C(CH_2OH)_2-CHO \xrightarrow[\text{from HCHO}]{(H)} CH_3-C(CH_2OH)_3-CHOH \qquad (4)$$

The reaction is carried out in the presence of caustic soda and at a temperature of 30-40° C. The crude trimethylol ethane is extracted by a suitable solvent (e.g., isobutanol) and is finally refined by crystallization and sublimation. Overall yield in the process is 90% of theory (based on propionaldehyde).

N-Butyraldehyde

Many markets for this chemical are already firmly established. Its production at Tennessee Eastman's Oxo plant goes into three principal outlets: (a) Conversion to butyl alcohol and butyric acid for use in manufacturing cellulose acetate butyrate and Tenite plastic; (b) self-condensation of two molecules of butyraldehyde and subsequent conversion to ethyl hexyl alcohol for use in manufacturing the plasticized dioctyl phthalate; (c) the remaining aldehyde is sold as such.

One of the most significant reactions of butyraldehyde is with polyvinyl alcohol to form polyvinyl butyral. PVB finds large-scale application as an interlayer for safety glass as well as for coating fabrics.

Butyraldehyde can be condensed with aniline or other amines such as monobutylamine to form an important series of rubber accelerators. Condensation of butyraldehyde with phenol will yield an important class of oil-soluble resins. The self-condensation of two molecules of butyraldehyde for the eventual production of ethyl hexyl alcohol has been referred to above. An intermediate in this conversion is 1-ethyl hexenal which may serve in the synthesis of 1-ethyl hexoic acid and of the mosquito repellent 2-ethyl -1:3 hexane diol.

Butyraldehyde Derivatives

Probably the most important derivatives of butyraldehyde are *butyric acid* and *its anhydride*. The necessary conversion is carried out by a fairly simple air oxidation step in the presence of manganese salts which serve as catalyst. These compounds are used extensively in the production of cellulose butyrate, or of mixed esters such as cellulose acetate butyrate. This group of chemicals is of significance in the manufacture of lacquers and of plastics for molding purposes. Another important line of butyric acid derivatives are its simple esters which serve as flavoring agents.

A reaction, analogous to Equation (4), will convert butyraldehyde to trimethylol propane, another substitute for pentaerythritol or for glycerine in some of its applications.

1-Butanol

Butyl acetate, produced by the esterification of acetic acid with 1-butanol, is considered the best medium-boiling solvent for nitrocellulose. In this function it finds widespread application in nitrocellulose lacquers.

1-butanol itself is a useful solvent for urea-formaldehyde resins. It serves as raw material in the production of di-n-butyl phthalate, an important plasticizer.

Butylamines, formed by the reaction of butanol with ammonia or various primary amines, are important intermediates in the production of resins and of a variety of flotation agents for use in the nonferrous mining industries. Other derivatives of butylamines include a class of emulsifying agents and of rubber vulcanizing accelerators.

Isobutyraldehyde and Isobutanol

Outlets for isobutyraldehyde are not as highly developed as for the straight-chain compound. It can be used for a number of the purposes outlined above for n-butyraldehyde. Due to its formation as a significant by-product in the Oxo synthesis of the normal compound, specific markets will have to be developed for isobutyraldehyde.

Isobutanol can serve for the production of isobutylamines for eventual conversion to flotation agents and vulcanization accelerators. Tennessee Eastman Company reports that great promise is shown in the substitution of isobutyl alcohol and acetate in lacquer formulations currently using n-butyl solvents.

Octyl and Nonyl Alcohols

At this time, these are the most important Oxo-synthesized chemicals on the American market. These alcohols can be reacted with phthalic anhydride or with phosphorous oxychloride to form plasticizers of outstanding usefulness in the forming of vinyl chloride and vinyl chloride-vinyl acetate resins and of Buna N-type rubbers.

Sparks and Young[17] have investigated the plasticizing performance of phthalates and phosphates derived from C_8- and C_9-Oxo alcohols. They report that these esters can serve as fully satisfactory replacements for the corresponding compound derived from 2-ethyl hexanol.

It should be noted that the latter alcohol has been used in this application for a considerably longer period. As a derivative of butyraldehyde, 2-ethyl hexanol has of late also become an indirect product of the Oxo reaction (see above). It is moreover claimed that the new Oxo plasticizers, if manufactured by suitable esterification processes, have better odor characteristics than those produced from 2-ethyl hexanol and that they have higher resistance to ultraviolet light. The phthalate esters of Oxo octyl alcohols proved to be about 10% more efficient than the corresponding C_8 plasticizers, and it is the former group of compounds which has found the widest commercial acceptance.

Higher Oxo Alcohols

Straight-chain alcohols in the C_{12}-C_{18} range can be converted to highly efficient detergents of the alcohol sulfate type. The efficiency of these detergents depends on the extent to which chain branching is absent. The best detergents of this type are derived from normal primary alcohols which have the hydroxyl group at the end of the chain. It has been shown above that the Oxo reaction, even under the most favorable circumstances can produce alcohols of such perfectly straight-chain character in yields of not more than 50-60% of theory.

Since there is no suitable source of higher straight-chain olefins available in the United States at the present time, the subject is of somewhat academic importance. Be it noted for the record, however, that the first Oxo plant at Ruhrchemie had the objective of producing alcohols for this function from Fischer-Tropsch hydrocarbons, which are notable for their straight-chain character. The optimum detergent properties were found to be associated with the C_{14}-C_{15} alcohol sulfates.

Attempts to utilize in this application olefins derived from petroleum sources or from the polymerization of lower olefins, did not give satisfactory results. The alcohol sulfates so synthesized were too highly branched to yield a product of good detergency.

Illustration Credits

The flow diagram of an American version of the Oxo process is through the courtesy of Blaw-Knox Co. The photographs are through the courtesy of Esso Standard Oil Co.

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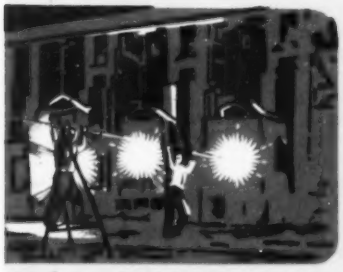

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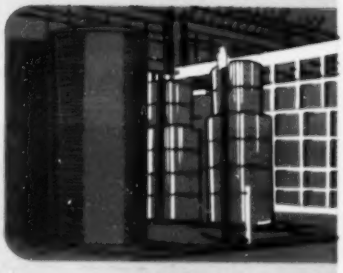

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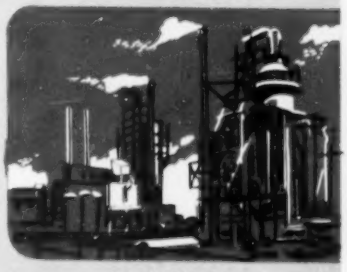

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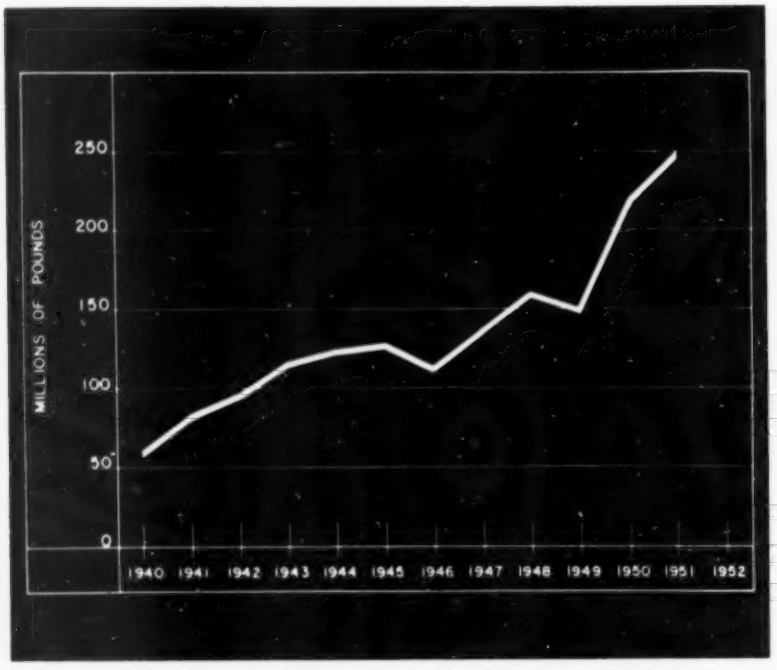

FIG. 1—U. S. production of phthalic anhydride since 1940

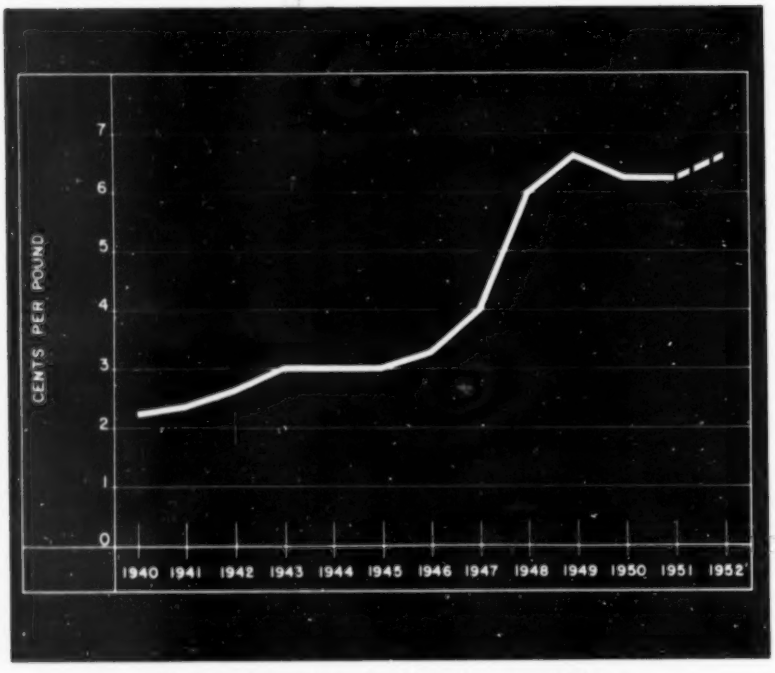

FIG. 2—Upward trend in the price of naphthalene

NAPTHALENE and NITROGEN

New Volume Source for Petrochemicals?

By OSGOOD V. TRACY
Esso Standard Oil Co.*

NAPHTHALENE is another chemical that has some similarity to benzene with respect to its economics and its relation to the petroleum industry. It has been in the forefront of the chemical news for the past 10 years because there has hardly been a time, in war or peace, when there has been enough of it. Primarily this is of course because of the steadily increasing market for phthalic anhydride.

In wartime we needed the phthalic anhydride to make the dibutyl phthalate to plasticize smokeless powder. We needed phthalic to produce the insectifuges to protect our troops and to produce the alkyd resins to paint military equipment, to make plasticizers and so on for a score of other essential indirect military uses.

When peace came the expansion of facilities for phthalic production paused only momentarily in its uptrend and then proceeded to new heights, demanding more and more naphthalene every year. The best plasticizers for vinyl resins are based on phthalic, and peace time uses for these resins took up where war demands left off.

An even larger use was the continued development of alkyd resin paints and coatings. Even now, with phthalic anhydride production at 250,000,000 lbs/yr., the limit does not appear to be in sight. Vinyl resins are still expanding and so are alkyds. In fact, it is understood that the development of low pressure laminates may well open another large field to alkyd resins.

Our current and prospective mobilization efforts will superimpose other and new demands on phthalic. For example, the employment of even small amounts of phthalic anhydride in rocket fuel may develop into military requirements that could exceed anything we have envisaged so far. More and more phthalic means more naphthalene. If we disregard the temporary lull in business in the first half of this year and forget about the steel strike for the moment, it is apparent that we do not have enough naphthalene.

Phthalic anhydride producers have been getting by through importing naphthalene from Europe, but this is a diminishing source, as other countries are beginning to produce

*Mr. Tracy, general manager, chemical products dept., Esso Standard Oil Co., has just been elected president of Enjay Co., Inc., an Esso sales affiliate. Recently returned from a leave of absence as director of the chemical division of National Production Authority, he will continue his post with Esso. This article is based on a report presented at the annual meeting of American Coke and Coal Chemicals Institute, White Sulphur Springs, Sept., 1952.

phthalic or other naphthalene-consuming chemicals for themselves. To insure adequate supply, more naphthalene must be recovered from coal tar streams or from petroleum streams, or more alternate raw materials for phthalic anhydride must be produced, such as orthoxylene or perhaps even methyl-naphthalene. Fig. 1 shows the U. S. production of phthalic anhydride since 1940.

The cost of production is the controlling factor in the development of means for supplying naphthalene or alternate materials for phthalic anhydride. Until 1948, the low-cost easily-recoverable portion of the naphthalene recovered from coal tar had been sufficient and prices did not warrant even the sizeable investment necessary to produce the more difficultly-recoverable portions from coal tar, to say nothing of its production from other sources, as for example, by the difficult and expensive separation of orthoxylene from its associated isomers.

The steadily rising demand has been reflected in naphthalene prices and the present level of 6¾ cents/lb. for 78°, coupled with the incentive of accelerated tax amortization, has resulted in notable expansion in naphthalene producing facilities in the coal tar industry. The National Production Authority has set a target of 555,000,000 lbs. of naphthalene by 1957 and it is reported that Certificates of Necessity have already been granted for 515,000,000 lbs. Present day demands are larger than could be accounted for in the expansion of coke facilities and, therefore, must represent more intensive recovery of naphthalene than has been practiced heretofore. When a situation develops in which demand substantially exceeds supply and price justifies more expensive recovery, then the production from petroleum of naphthalene and more orthoxylene may be expected. Fig. 2 shows the upward trend in the price of naphthalene.

Nitrogen

Part of our future large requirements of nitrogen, largely for agricultural purposes, may have to be met by synthesizing this chemical from natural gas and petroleum, as well as from the coal and coke industry.

In 1939-40 we consumed in this country 538,000 tons of nitrogen — 383,000 tons for agricultural needs. Our goal for 1955 is 2,900,000 tons of nitrogen, of which 2,000,000 tons will be for agriculture. This fivefold increase is expected to be only enough to meet the goals of increased food production, especially grain. The reason for this tremendous increase is of interest.

Until quite recently, our increased food necessity has been achieved by increasing tillable land and by improving yields through the development of better seed. Today we have about reached the limit of further increasing acreage, and the use of hybrid seed is at a maximum. Very simply, this means that further increases in food production must come from increased yields per acre.

It is interesting to note how modern methods of growing adapted corn hybrids in thick stands at high fertility pays off. Cooperative research by the Department of Agriculture and the Mississippi Agriculture Experiment Station showed that the average yield of corn in the experiments was 22 bushels/acre where no nitrogen was applied and the corn

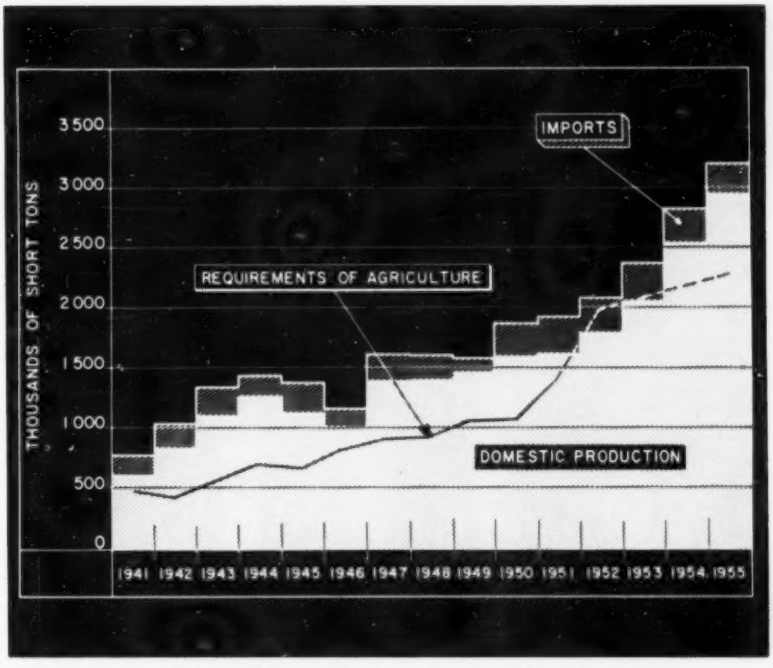

FIG. 3—U. S. supply and requirements for nitrogen

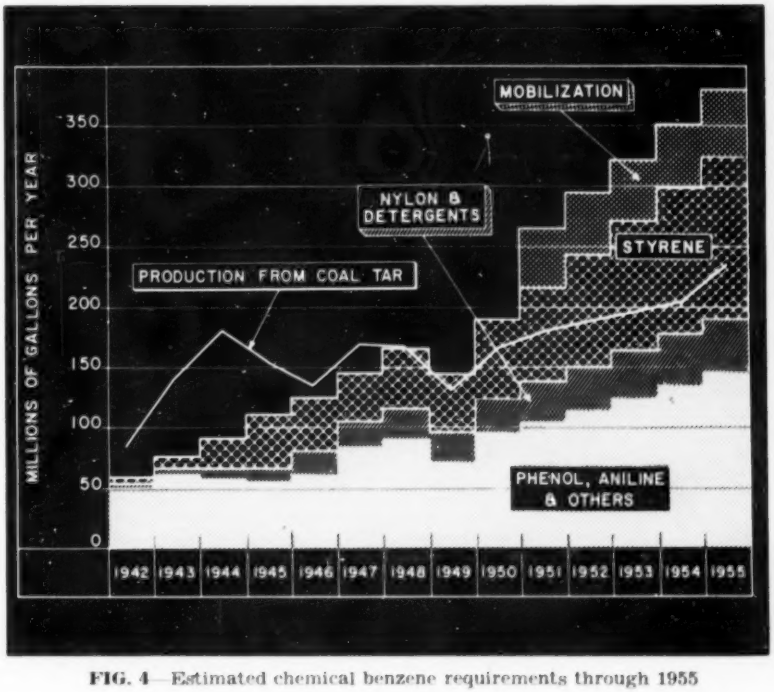

FIG. 4—Estimated chemical benzene requirements through 1955

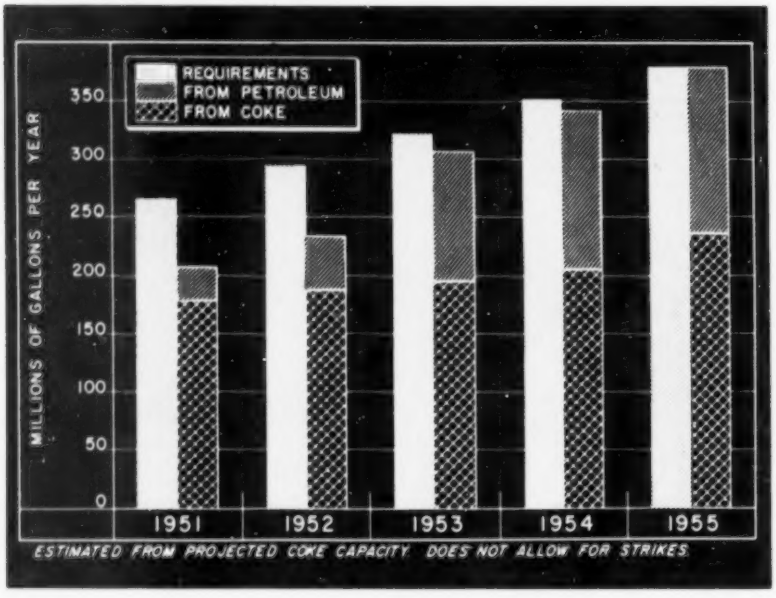

FIG. 5—Requirements for chemical grade benzene and estimated supply from petroleum and coke sources

was thinned to 4000 plants to the acre. Where 120 lbs. of nitrogen was applied and the stand of adapted hybrid increased to 12,000 plants/acre, the average yield was 72 bushels/acre.

Part of this huge nitrogen requirement will come from the coal and coke industry, some of it will be synthesized as ammonia from coal, a larger part from natural gas and some of it will come from petroleum. Even the benzene from petroleum, through platforming operations, will produce hydrogen for ammonia synthesis. Fig. 3 shows the U. S. supply and requirements for nitrogen.

The increasing demand for coumarone indene resins from coal tar provides another example of how different sources of supply supplement one another in supplying a national market. The demand for floor tile resins and other low-price resins far exceeds the available supply of coumarone indene, but these resins from coumarone indene are highly compatible with similar but not identical resins that can be polymerized from certain petroleum fractions. The two materials, one from coal tar and the other from petroleum are not ony compatible but to some extent mutually plasticizing, with the result that the field of both has been notably broadened and extended.

The effect of the dual supply of chemical raw materials from petroleum and other sources on the price structure for the materials is also of interest. Considering all the cases where petroleum has been called upon to fill a gap between supply and demand it will be noted that often the petroleum chemical does not sell at the same price as the same chemical from another source. Sometimes the petroleum chemical is at a lower price, as in the case of ethyl alcohol and sometimes at a higher price, as is the case with benzene.

If we are to supply our chemical markets from two sources of raw materials, coal and petroleum—the former producing chemicals of necessity as co-products, the latter producing them "on order" so to speak —we will have to accustom ourselves to two sets of prices for the same material, depending on origin.

We are familar with two prices on toluene, although over the years the coal tar and petroleum toluene have tended to come close together. We have two prices today on benzene, with a sizeable spread between the two sources. This is justified by actual costs. As time goes on, however, the spread may narrow although it is difficult to see under present processes how it will actually close. The bulk of coal tar benzene must be disposed of as produced, and it probably will always be quoted at a discount, compared with petroleum benzene, to secure its ready movement. The same relationship of two prices will probably obtain in naphthalene when and if it makes its appearance in large volume from petroleum.

The dual price relationship to the production of benzene is an important factor. As early as 1947 it became apparent that the demand for benzene was outstripping the domestic supply and that supplementary sources must be developed. The oil companies had already learned that this chemical could be produced in hydroforming operations but it could not be done economically at the then prevailing price for coal tar benzene, around 17 cents/gal. The oil companies did not relax their research efforts in this direction, however, knowing that price considerations would ultimately take care of themselves if the demand grew as had been anticipated. Fig. 4 shows estimated chemical benzene requirements through 1955 and Fig. 5 requirements for chemical grade benzene compared with supply. In more recent years it became evident that, despite the expansion of coke making facilities in steel plants, the benzene supply from coal would be only about 60% of what will be needed.

It was the realization of this fact that finally brought benzene from petroleum into the picture. Chemical manufacturers, resin producers, detergent makers and others knew that their combined demands were exceeding supply and that contracts must be drawn at prices which would encourage benzene output from petroleum sources.

Many petroleum refiners were prepared for this development by somewhat unrelated circumstances. This means that the continually rising demands for higher octane gasoline which accompanied new engine design had fostered long continued research on methods of producing more and more tailor-made branch chain aliphatic and aromatic materials from petroleum streams. Various types of cracking, reforming, hydroforming and platforming had been developed, many of which could be adapted to the production of benzene and other aromatics. When the prospective demand urgently called for petroleum benzene it began to materialize. In the case of Esso Standard Oil Co., we were prepared to turn out benzene by extractive distillation of steam cracked distillates, as one route. Others turned to Platforming and other methods.

The first significant appearance of petroleum-derived benzene was in 1950. As more facilities came into operation, what began as a trickle swelled to a sizeable stream. Last year, according to the U. S. Tariff Commission, 28,000,000 gals. of benzene were produced from petroleum. The 1952 volume may reach 45,000,000 gals. and, on the basis of projects approved, the output by 1955 is estimated at about 145,000,000 gals. This will supplement the 235,000,000 gals. which must be either produced by coke ovens and tar distillers, or imported to satisfy the total 1955 demand of 380,000,000 gals.

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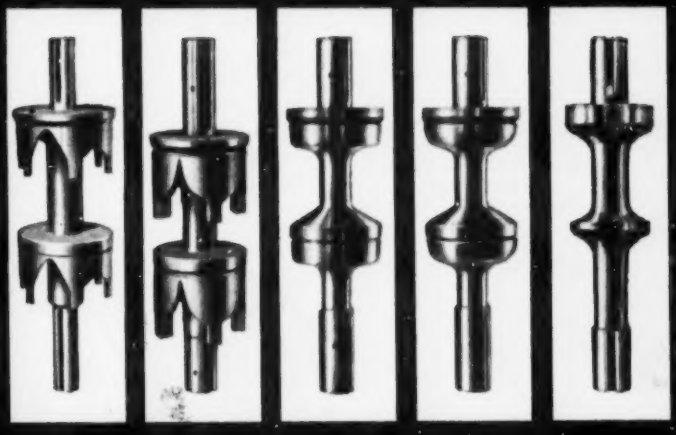

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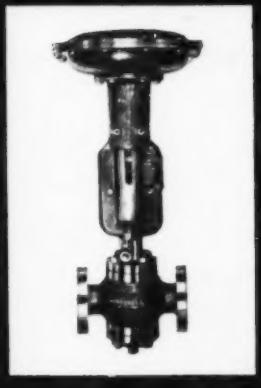

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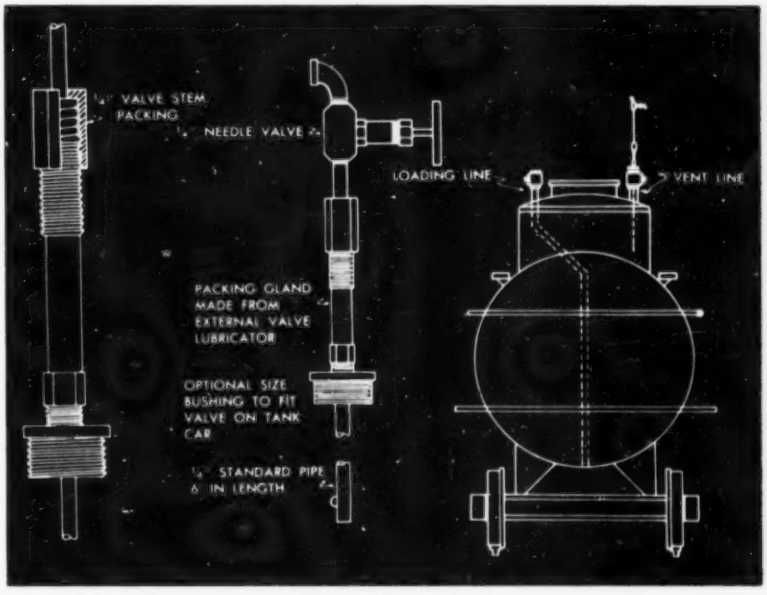
Safe Car Loading of Volatile Gasolines

By W. B. NORRIS*

THE problem was to find a safe and efficient method for sampling and loading tank cars with high vapor pressure gasoline without having to remove the dome cover during seasons of high temperatures. The solution was the slip-tube assembly shown in the drawing.

An external valve lubricator was modified by drilling out the grease channel to permit a 6-ft. length of ¼-in. pipe to be inserted. The plug in the grease cup of the lubricator was removed. Valve stem packing of ¼-in. size was then wrapped as shown around the pipe, and the lubricator cup was tightened to prevent leakage around the pipe. A ¼-in. needle valve and a street ell were then attached at the upper end of the pipe, and a bead weld was added to prevent the tube from slipping out of the packing gland.

The slip tube is mounted on the tank car as shown, with the proper size bushing to fit it on the vent line. The dome cover is removed in order to set the slip tube to the desired outage, then the cover is replaced. When the car has the proper outage, liquid will flow from the top of the slip tube. The tube is then pulled out as far as possible, the vent valve is closed, and the tube removed from the car.


¼" VALVE STEM PACKING
¼" NEEDLE VALVE
LOADING LINE
VENT LINE
PACKING GLAND MADE FROM EXTERNAL VALVE LUBRICATOR
OPTIONAL SIZE BUSHING TO FIT VALVE ON TANK CAR
¼" STANDARD PIPE 6" IN LENGTH

*Mr. Norris is with Sun Oil Co., Delhi, La. This item is based on his award-winning "Plant Kink" from the southern regional meeting of the Natural Gasoline Ass'n. of America, Tyler, Texas, October 24, 1952.

Automatic Boiler Chemical Injector

By L. L. POTTHOFF and SAM SUMMERS*

TO ELIMINATE the human element in addition of boiler water treatment, an automatic device was developed which requires no manual operation in the injection of treating chemicals.

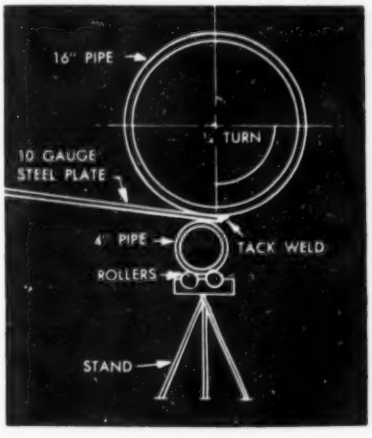
It was found that the chemicals should be added at intervals considerably less than once each eight or 24 hrs., because the treatment becomes more effective. A completely automatic injector was therefore built which would inject at 30-min. intervals and operate on about a 7-day run. It consists chiefly of a length of 16-in. pipe with two welding caps to form a tank of approximately 75-gal. capacity, and a feeder made up of a 7-day "Macnick" clock equipped with a disc notched once for each 30 minutes and an old discarded Hanlon-Waters pilot valve.

In operation, the disc which is attached to the clock releases at 27-minute intervals air to the pilot. This opens a motor valve and lets chemical enter the hot well from which the boiler feed pump takes suction. There is approximately 6 psi. pressure on the boiler hot well and about 8 psi. pressure on the chemical tank.

The motor valve is in an open position for about three minutes out of each 30; however, this time can be adjusted as needed by moving the clock away from the pilot valve a short distance. Thus any amount of chemical can be added as is required. The tank is equipped with a gage glass, and it has been calibrated so that the correct quantity of chemicals can be added each day.

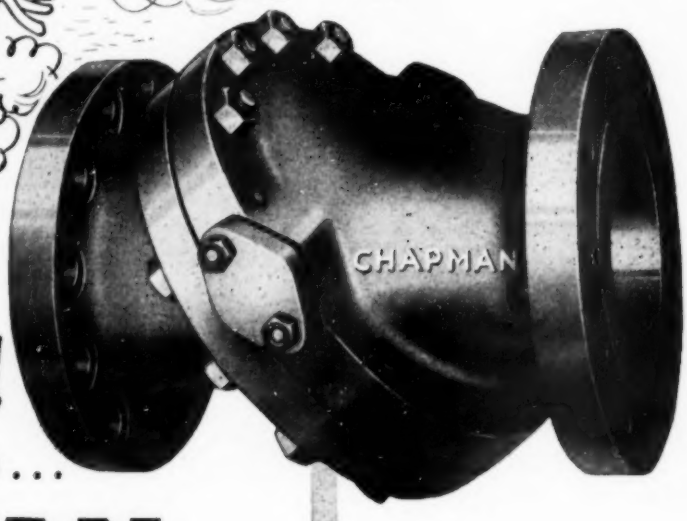
This unit has been in service for about a year and it has required little or no attention except that once each 7 days the tank must be refilled with treating chemical. Surplus equipment was used to construct the entire device except for the clock.

*Mr. Potthoff and Mr. Summers are associated with Warren Petroleum Corp. at Gladewater, Texas. The preceding short article is based on their prize-winning idea presented at the "Plant Kinks" session at the Tyler, Texas, meeting of the Natural Gasoline Ass'n. of America, Oct. 24, 1952.



Want to Bend Plate? Here's a Quick Way

AN EASY method for bending steel plate, developed and used at the Calgary, Alberta, refinery of British American Oil Co. Ltd. is illustrated in the accompanying sketch. The job was to bend 10-ga. steel plate



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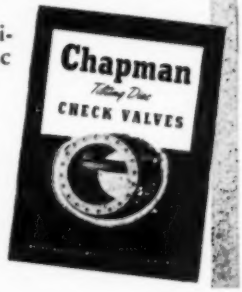

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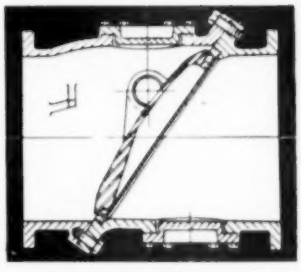
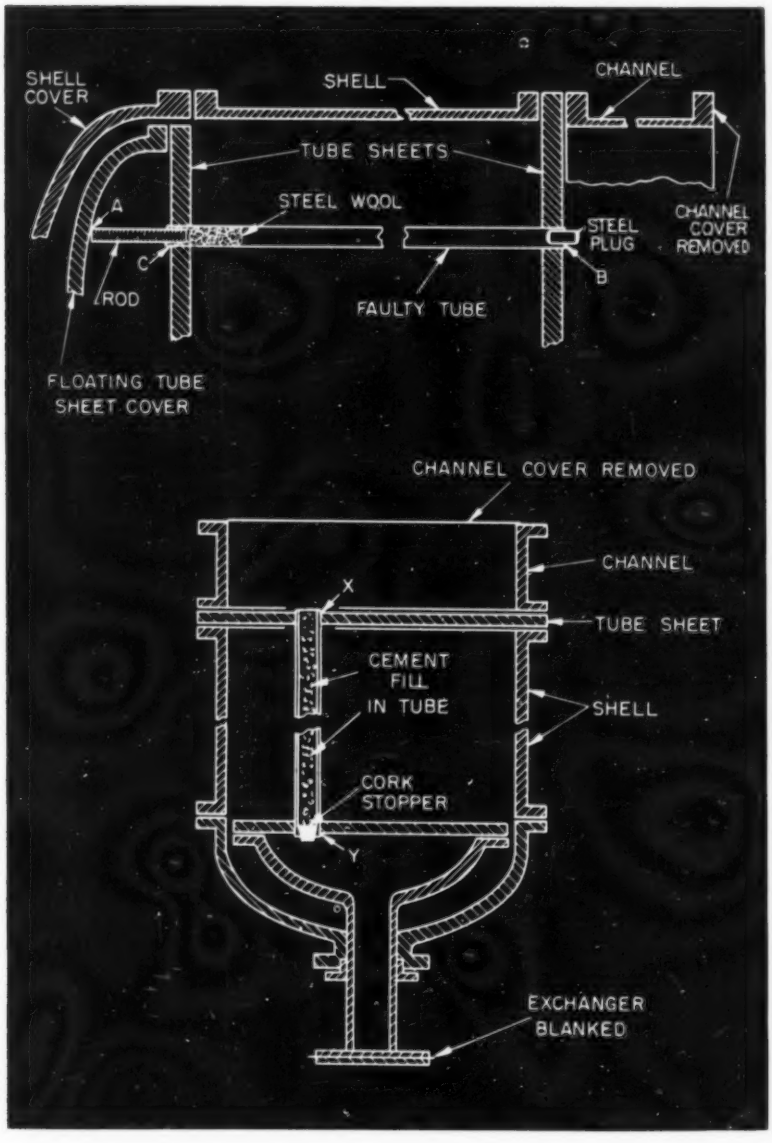


Cross-section of the Chapman Tilting-Disc Check Valve. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.

into a 90° bend with an approximate 8-in. radius.

One end of a 10-ft. length of 16-in. diameter pipe was fastened in the chuck of a pipe threading machine. The other end was supported by a greased chain. A piece of 4-in. pipe was set on rollers close to the 16-in. pipe. The 10-ga. plate was then placed over the smaller pipe, under the larger, and tack welded to the larger. Then the pipe machine was switched on and the 16-in. pipe turned slowly through a quarter-turn. The plate was broken loose and there was the desired bend.



How to Stop Exchanger Leaks

FAST, easy, temporary repairs on leaking tubes in heat exchangers can be made by two simple methods, using cement or steel wool, worked out by maintenance personnel at the Philadelphia refinery of the Gulf Oil Corp. They are illustrated in the accompanying sketches, and consist essentially of means for plugging off the faulty tubes.

In the case of a horizontal bundle, the repair can be done by removing only the channel cover. Distance *CB*, between the tube sheets, is of course known. Distance *AC*, which varies according to which tube is being repaired, is determined by measuring distance *AB* with a long rod and then subtracting *CB* from *AB*. Then a close-fitting rod is cut to length equal to *AC* plus ¾ in., and pushed through the faulty tube to the position indicated on the drawing. Following this, steel wool is rammed in behind the rod to a depth of about six in. This insures sealing off that end of the tube. The other end is sealed with a steel, tapered plug at point *B*, and the tube is thus out of service.

Repairing a vertical exchanger bundle is illustrated in the lower drawing. the top channel cover only is removed. The leaking tube is located by applying 10 psi. air pressure on the shell side and filling the tubes with water. Air bubbles will come out of the faulty tube at the stationary tube sheet end. The water is then drained out of the bundle. Distance *XY*, between the tube sheets, is known. This distance, *XY*, less ¾ in., is marked off on a rod with which an ordinary cork stopper is forced through the faulty tube to the location *Y* in the tube sheet. The rod is withdrawn and the leaking tube is then filled with a thin mixture of a quick-setting cement which renders the tube out of service.

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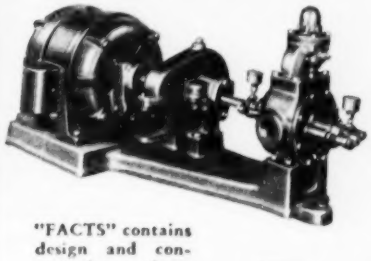

"FACTS" contains design and construction, maintenance, operation and application data for better pump service.

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(To obtain more data on advertised products see page 280)

Long-lasting Stainless Steel

reduces maintenance at Gulf's Lube Oil Phenol Extraction Plant

IN job after job, Stainless Steel repeatedly has demonstrated its ability to reduce maintenance and resulting downtime through its excellent resistance to corrosion and other severe conditions so often encountered in the petroleum industry.

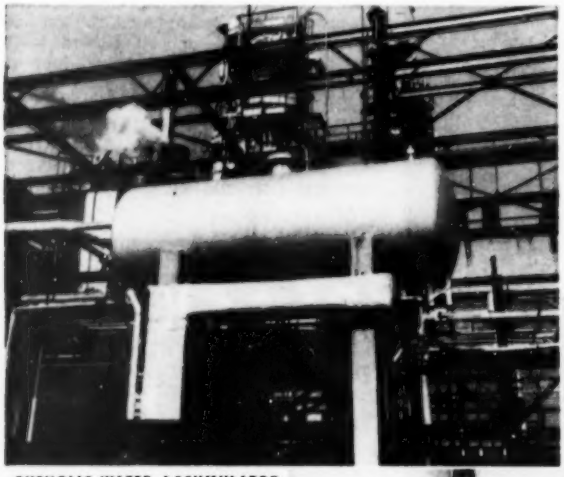
For example, in the Lube Oil Phenol Extraction Plant (Multisol No. 3) at Gulf Oil Corporation's Port Arthur, Tex., operation, three specific installations of Stainless Steel have played an important role in reducing over-all downtime.

The phenolic water accumulator—handling a solution of 10% phenol and some naphtha—is lined with Stainless Steel ¼" thick and 12" wide. It has been in service for nine years and remains in good condition, although carbon steel plates used previously blistered after two years of service. The vessel operates at a pressure of 5.0 psi and at 170°F.

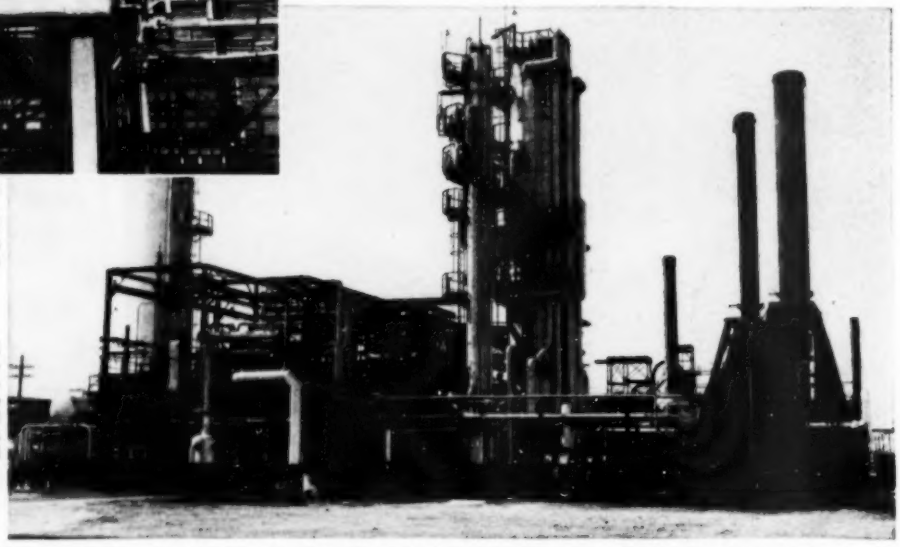
In the extract heating furnace, the last 16 tubes are Stainless Steel and have been in service for 7½ years without need for maintenance. Carbon steel tubes in these locations failed after 18 months of service.

The drier section of the phenol tower itself is lined with Stainless Steel as a protection against rapid corrosion at tray level.

There are many locations in your plant where the proper grade of Stainless Steel can help you maintain uninterrupted production. Our metallurgical and research personnel will be glad to assist you with recommendations. There is no obligation, of course.



PHENOLIC WATER ACCUMULATOR is lined with Stainless Steel. The Stainless lining has lasted nine years—against two years for carbon steel—and is still in serviceable condition.



OVER-ALL VIEW of Lube Oil Phenol Extraction Plant (Multisol No. 3) at Gulf Oil Corporation, Port Arthur, Tex. The phenol tower is in the center and the extract heating furnace at the right. Both are equipped with Stainless Steel.

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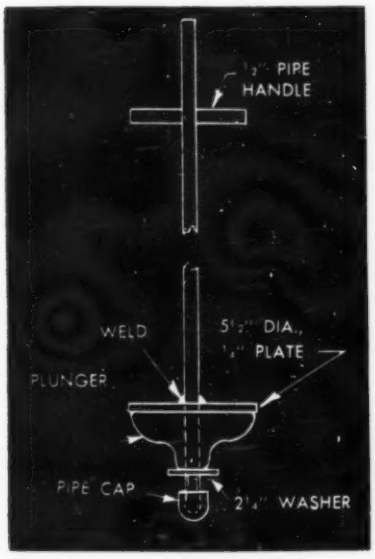
UNITED STATES STEEL

"Stopper" Permits Valve Repairs



By R. V. STRUEBING*

THE rubber plunger from an ordinary plumber's friend and a length of pipe can serve as an emergency tank "stopper" to facilitate replacing a leaking plug valve on the outlet line from a concentrated sulfuric acid tank. The device has been used twice to change such valves at Skelly Oil Co.'s El Dorado, Kans., refinery.

The materials are readily available and easily made up. The plunger made a tight sealing internal valve so that there was no leakage or drip while the plug valve was being replaced. The hollow plunger showed advantages over a solid rubber valve in making a better fit over an irregularly shaped hole.

The emergency valve is shown in the drawing. A length of ½-in. pipe was welded to a piece of ¼-in. steel plate, 5½ in. in diameter, with 4 in. of pipe extending below the plate. The rubber plunger was then slipped on, with the wide portion against the steel plate, and followed by a steel washer, 2¼ in. in diameter; the washer in turn being held on by a pipe cap. The washer served not only to keep the plunger in position but also as a centering device when the emergency assembly was inserted in the 3-in. nozzle inside the acid tank.

A handle of ½-in. pipe was welded on the top end as an aid in lowering and removing the tool. If desired for various size vessels, the pipe could be threaded for addition or removal of extra pieces of pipe to alter the length. This type emergency valve can be made up and kept for use for any kind of liquid materials where there is an opening in the tank above the outlet connections.

* Mr. Struebing is process engineer, Fluid catalytic cracking unit, Skelly Oil Co., El Dorado, Kans.

IDEAS—Wanted!

Good ideas, plant shortcuts, gadgets, and the like are always valuable in your own plant. Why not pass some of your ideas along to others? Send them to us, along with photographs, sketches, etc. Don't worry about how they look. Just include the important facts. We'll dress up the idea and put it on these pages.

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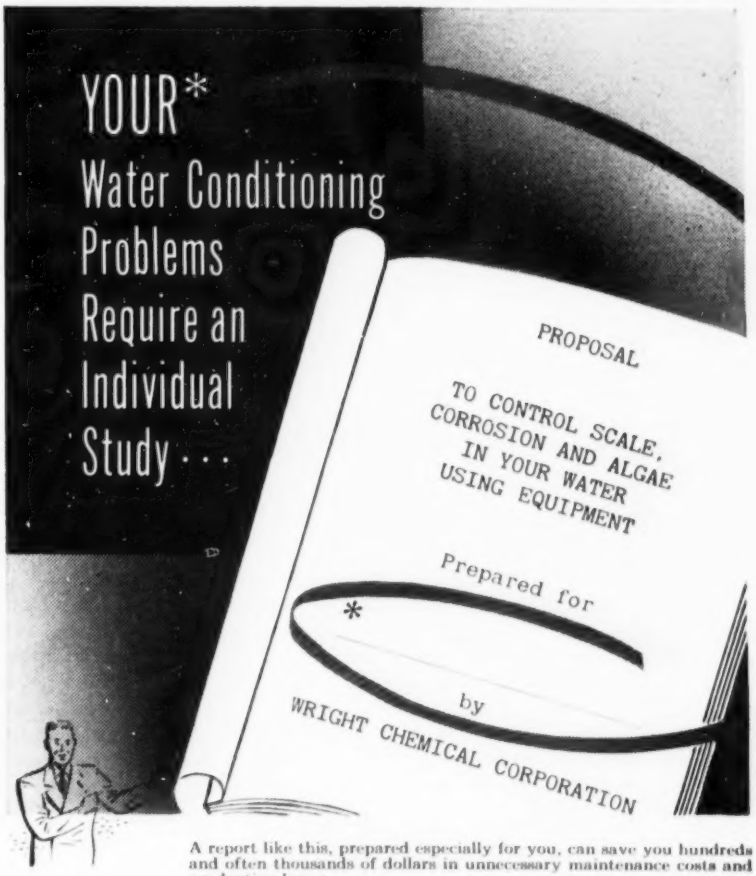

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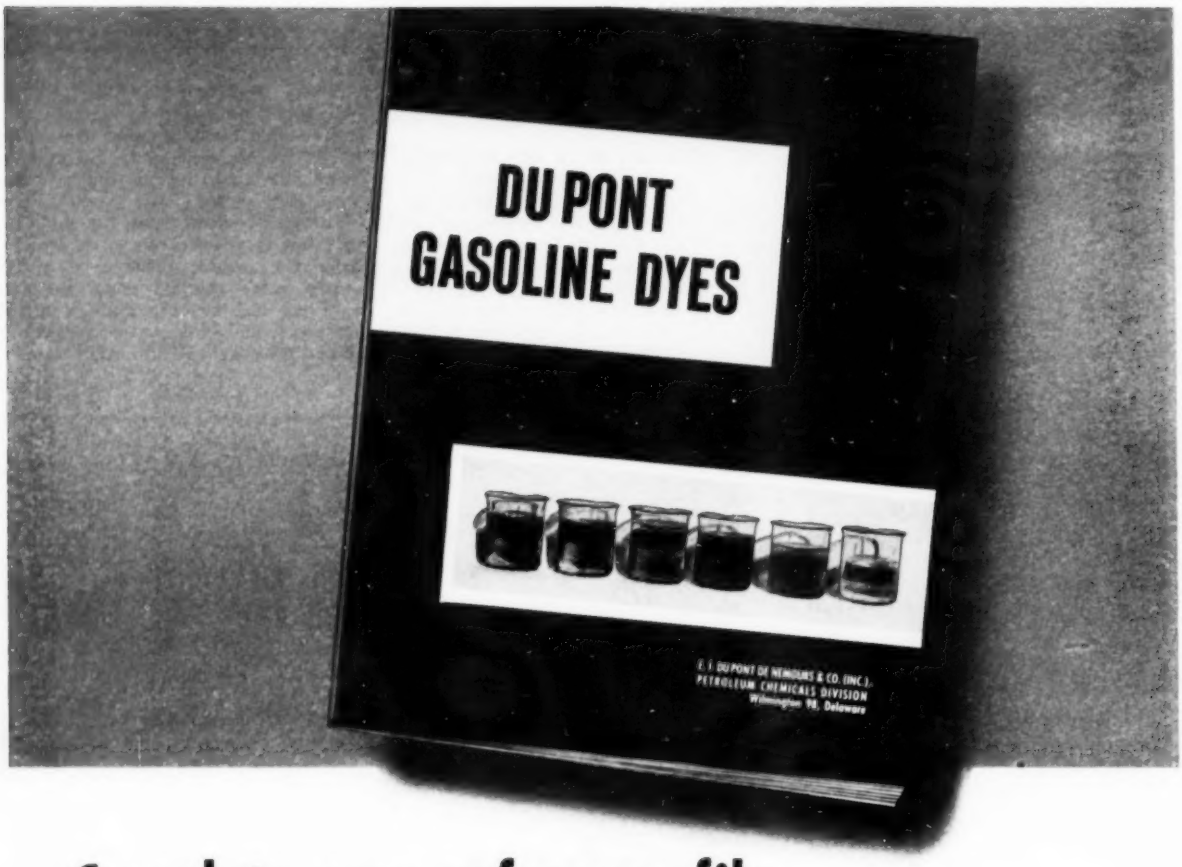

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The booklet also gives complete information on all Du Pont gasoline dyes—including solubility charts and spectrophotometer curves. And it contains much helpful information on handling dyes; such as how to remove dye stains from clothing and equipment plus useful shipping information.

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By Peter J. Gaylor, *Patent Attorney, Gaylor, Cifelli & Jurick, Newark, N. J.*

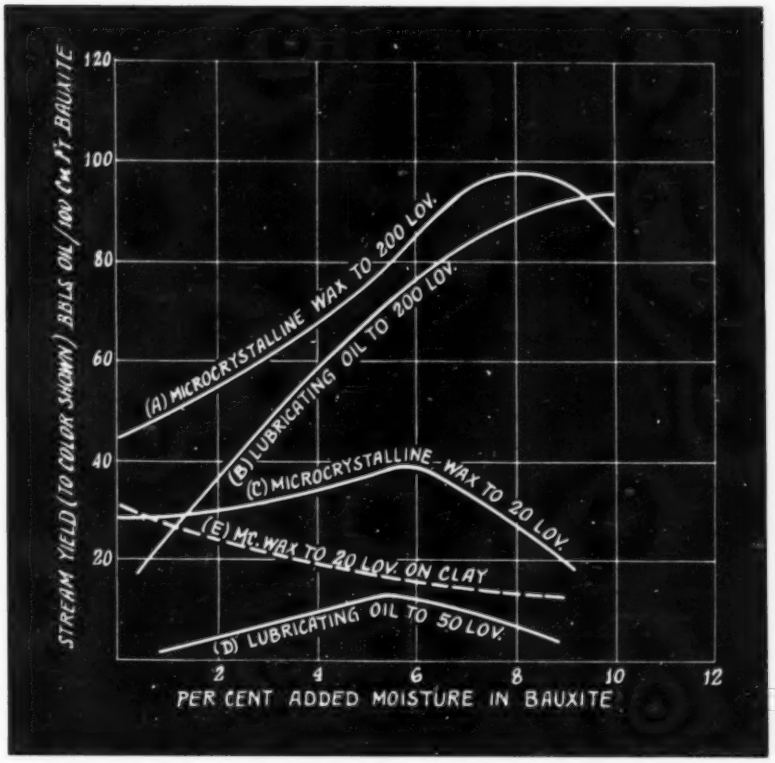

FIG. 1—Effect of added moisture on decolorizing power of "dry" bauxite (U. S. 2,596,942—Socony-Vacuum Oil Co.)

Decolorizing Efficiency of Bauxite Is Improved by Addition of Water

THE addition of at least 2% by weight of water to heated bauxite is claimed to improve considerably its decolorizing efficiency, according to the Socony-Vacuum Oil Co. patent U. S. 2,596,942.

As mined, bauxite is practically worthless for adsorbent purposes. For oil filtration, it is customary to heat the mineral to 600°-1600° F. so as to remove at least some of its water of constitution. Removal of water of constitution is rapid up to about 600° F., and relatively slow from there to about 850° F., at which temperature, if it is held for two hours, it is called "dry" bauxite. Apparently bauxite contains about 6% of water of constitution which can be reduced to about 2% by heating to 1000° F, and to 0% by heating to 1600° F.

The invention specified in the patent involves taking "dry" bauxite and adding to it controlled amounts of moisture by subjecting the mineral to an atmosphere of controlled humidity for controlled periods of time until 2-12% of water is taken up by the bauxite. In commercial practice, this is done by exposing the bauxite to tempering heating at 750°-850° F. and then to an air stream of controlled humidity (steam) for a specified time.

Fig. 1 shows the yields obtained when filtering to a specified color, using bauxite containing various amounts of added moisture. A maximum activity at 6-8% moisture is apparent. Curve E is included in the figure to show the typical data obtained with ordinary filter clay containing controlled amounts of moisture.

Titanium Polymers in Oils

BY heating an alkyl orthotitanate such as tetraisopropyl titanate with at least one mole but less than two moles of water per mole of ester, with a carboxylic acid containing at least 4 carbon atoms, it is possible to recover a stable, oil-soluble polymeric titanium carboxylate. According to the Du Pont patent 2,621,195, such polytitanyl products are colorless to brown liquids or solids exhibiting novel surface-active properties.

In one example, stearic acid is heated with tetraisopropyl titanate at 50° C. for two hours, and a moderately viscous light brown liquid resulted. It was cooled to room temperature and the controlled amount of water was added dropwise with agitation. The resulting liquid then was heated at 50° C. under reduced pressure to strip off the isopropanol by-product. A light brown, waxy residue was obtained which was extracted with acetronitrile to remove unreacted stearic acid. The product was found to contain 1.5 moles of stearic acid per mole of titanium, i.e. it was polytitanyl sesquistearate.

Since the polymers possess novel surface-active properties (the patent does not amplify this), they are claimed to be particularly valuable as detergents and additives for lubricating oils, as well as greases, paints, etc.

Patents Issued in December

The following classified listing gives the patent number, patentee or assignee, and a brief description of all patents believed to be of interest to the petroleum processing industries, as contained in the Official Gazette of the U. S. Patent Office for December 2, 9, 16, 23, *and* 30, 1952, *Vol.* 665, *Nos.* 1-5.

PROCESSES

Catalysts

2,620,314 (Universal Oil Products Co.) Spheroidal alumina.

2,623,020 (Standard Oil Development Co.) Preparation of zinc aluminate spinels and the addition of group VI catalysts thereto.

2,623,860 (Universal Oil Products Co.) Method of manufacturing platinum-containing catalyst.

2,623,861 (Universal Oil Products Co.) Preparation of alumina-platinum-halogen catalyst.

Conversions

2,620,293 (Phillips Petroleum Co.) Conversion of oil residua to lighter hydrocarbon cracking stock by use of naphthene hydrocarbon hydrogen donor.

2,620,361 (Standard Oil Development Co.) Method of alkylating and polymerizing hydrocarbons in the presence of a stabilized phosphoric acid catalyst.

2,620,364 (Atlantic Refining Co.) Polymerization of olefins with a boron phosphate catalyst.

2,620,967 (The Lummus Co.) Gas ejector apparatus for a catalyst regenerator.

2,621,113 (Universal Oil Products Co.) Apparatus for catalytic conversion of hydrocarbons.

2,621,148 (Houdry Process Corp.) Art of converting hydrocarbon material.

2,621,150 (Fernando M. Mora) Method of and apparatus for the thermolytic decomposition of heavy liquid hydrocarbons.

2,621,216 (Shell Development Co.) Production of ethylene by pyrolysis.

2,622,113 (Universal Oil Products Co.) Production of long chain olefinic hydrocarbons by polymerization.

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Patents

2,622,935 (Phillips Petroleum Co.) Solid catalyst injection apparatus.
2,622,937 (Standard Oil Co.—Ind.) Prevention of erosion in pipe lines, using electromagnetic coil.
2,623,009 (Standard Oil Development Co.) Regenerative aluminum chloride process.
2,623,011 (E. I. du Pont de Nemours & Co.) Preparation of olefins by particulate coal carbonization.
2,623,075 (Standard Oil Co.) Isomerization of saturated hydrocarbons with sulfuric acid.
2,623,815 (Standard Oil Development Co.) Apparatus for gasifying carbonaceous fuel.
2,623,911 (Koppers Company, Inc.) Isomerization of aromatic compounds.

Hydrocarbon Synthesis

2,620,262 (Stanolind Oil and Gas Co.) System for synthesis from hydrogen and carbon monoxide with fluidized catalyst.
2,620,313 (Standard Oil Development Co.) Regeneration of fluidized iron oxide catalyst.
2,620,346 (M. W. Kellogg Co.) Synthesis of organic compounds by hydrogenation of CO.
2,620,347 (Ruhrchemie Aktiengesellschaft) Catalytic hydrogenation of carbon monoxide with iron catalysts.
2,620,348 (Standard Oil Development Co.) Hydrocarbon synthesis process with two-stage coke gasification.
2,621,117 (Texaco Development Corp.) Preparation of hydrogen and carbon monoxide gas mixtures.
2,621,203 (California Research Corp.) Adsorption separation of hydrocarbons and oxygenated organic compounds.
2,622,089 (Phillips Petroleum Co.) Method of reforming natural gas to produce hydrogen and carbon monoxide synthesis gas.
2,622,970 (Standard Oil Development Co.) Apparatus for hydrocarbon synthesis.
2,623,021 (Standard Oil Development Co.) Formation of an attrition-resistant Fischer-Tropsch catalyst.
2,623,022 (Standard Oil Development Co.) Preparation of a sintered hydrocarbon-synthesis catalyst bed.
2,623,057 (Hydrocarbon Research) Hydrocarbon synthesis.
2,623,058 (Standard Oil Development Co.) Process for the synthesis of hydrocarbons from carbon monoxide and hydrogen.
2,623,893 (M. W. Kellogg Co.) Hydrogenation of oxygenated organic compounds.

Refining

2,619,814 (The Lummus Co.) Fractional distillation.
2,620,047 (Standard Oil Development Co.) Adsorption process, using fluidized adsorbent of specific size.
2,620,175 (Phillips Petroleum Co.) Pebble heater apparatus.
2,620,362 (E. I. Du Pont de Nemours & Co.) Method of catalytically removing sulfur with sulfided salt.
2,620,363 (Standard Oil Development Co.) Method of separating normal paraffins from isoparaffins by a solid adsorption process using charcoal.
2,620,895 (Hudson Engineering Corp.) Separation and dehydration of heavy hydrocarbons from a gaseous mixture.
2,621,105 (Phillips Petroleum Co.) High-temperature solid material-fluid contact apparatus pebble heater and method of operation.
2,621,147 (The Texas Co.) Sweetening and stabilizing hydrocarbon oils by contacting with metal salt, phenylene diamine and N-salicylalamino alkane.
2,621,149 (California Research Corp.) Adsorption separation process.
2,622,062 (Tide Water Associated Oil Co.) Apparatus for automatic collection of liquid fractions.
2,622,114 (Phillips Petroleum Co.) Fractional crystallization proce'ss and apparatus.
2,622,115 (Phillips Petroleum Co.) Separation of eutectic-forming mixtures by crystallization methods.
2,622,416 (Standard Oil Development Co.) Separation of low boiling gas mixtures.
2,622,968 (Standard Oil Development Co.) Contacting plate for liquid-liquid extraction tower.
2,623,004 (Standard Oil Co.—Ind.) Desulfurization of distillate fuels by extraction with dimethylformamids.
2,623,005 (Phillips Petroleum Co.) Propane fractionation of lubricating oil stocks.
2,623,006 (Gulf Oil Corp.) Desulfurization of a hydrocarbon oil by contacting with iron oxide on carrier.
2,623,007 (Phillips Petroleum Co.) Catalytic desulfurization of hydrocarbons by contacting with chromia-alumina-beryllia.
2,623,008 (Phillips Petroleum Co.) Treatment of sour hydrocarbons with caustic solutions by chilling and separating out mercaptide.

(To obtain more data on advertised products see page 280)

2,623,813 (Universal Oil Products Co.) Apparatus for liquid-liquid contacting.
2,623,842 (Phillips Petroleum Co.) Hydrocarbon conversion process and reaction chamber for pebble heater apparatus.
2,623,843 (Standard Oil Development Co.) Refining of liquid or semiliquid carbonaceous materials (shale oil).

PRODUCTS

Chemicals

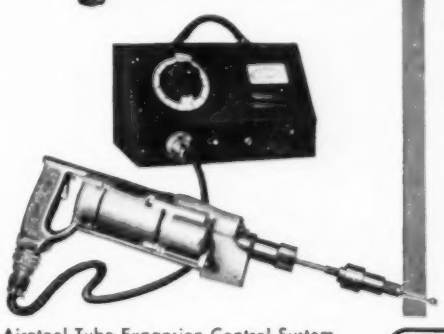
2,620,259 (Union Oil Co. of Calif.) Manufacturer of hydrogen cyanide from halo hydrocarbon, ammonia and oxygen.
2,620,294 (Standard Oil Development Co.) Extractive distillation of close-boiling alcohols.
2,620,323 (Standard Oil Development Co.) Age resistor for low-unsaturation polymers.
2,620,356 (Standard Oil Development Co.) Production of aromatic amines from nitro compounds.
2,620,357 (Standard Oil Development Co.) Production of unsaturated carbonyl compounds from glycols.
2,620,358 (Shell Development Co.) Catalytic oxidation of olefins in the presence of cuprous oxide.
2,621,153 (Shell Development Co.) Preparation of trichloroethane from ethylene dichloride and chlorine.
2,621,188 (The Texas Co.) Process for preparing thiophene homologs.
2,621,202 (Ernst Peukert and Friedrich Hilberath) Production of alcohols.
2,621,205 (Union Oil Co. of Calif.) Nitration of olefins.
2,622,069-70 (Petrolite Corp.) Process for inhibiting foam with phenol resin compound.
2,622,088 (Phillips Petroleum Co.) Ethylene oxide production and recovery.
2,622,106 (Socony-Vacuum Oil Co.) 1,1,2-Trichloro-1-fluoroethane.
2,622,107 (Ethyl Corp.) Manufacture of alkyl chlorides.
2,622,108-9 (Universal Oil Products Co.) Production of drying oils using HF.
2,622,110 (Universal Oil Products Co.) Production of di (cycloalkyl) alkanes.
2,622,111 (Universal Oil Products Co.) Catalytic hydrogenation of benzene with Pt on silica.
2,622,962 (Shell Development Co.) Polybutadiene filamentary product and process of preparing same.
2,623,032 (Standard Oil Development Co.) Two-stage emulsion polymerization process.
2,623,037 (Phillips Petroleum Co.) Sulfating polyvinyl alcohol.
2,623,049 (Socony-Vacuum Oil Co.) Preparation of halothenyl halides.
2,623,056 (California Research Corp.) Ester type drying oils and process for making the same.
2,623,061 (Sinclair Refining Co.) Process for reacting ammonia and olefins.
2,623,069 (California Research Corp.) Method of producing 4 - chloro - butane - 1 - sulfonyl chloride.
2,623,072 (Phillips Petroleum Co.) Separation of cyclopentanone.
2,623,073 (California Research Corp.) Preparation of unsaturated ketones.
2,623,074 (Standard Oil Development Co.) Production of alcohols and gasoline by the oxo process.
2,623,611 (Southern Production Co.) Method of separating acetylene.
2,623,814 (Phillips Petroleum Co.) Production of crystalline materials.
2,623,844 (Standard Oil Development Co.) Extractive distillation of isoprene with dimethyl sulfolane.
2,623,890 (Sinclair Refining Co.) Polymerization process to produce drying oils.
2,623,894 (Shell Development Co.) Production of higher alkyl esters of inorganic acids.
2,623,904 (Shell Development Co.) Nitro aldehydes and preparation thereof.
2,623,905 (Universal Oil Products Co.) Production of aliphatic aldehydes.
2,623,912 (Phillips Petroleum Co.) Manufacture of polycyclic aromatic compounds.

Fuels

2,619,830 (Phillips Petroleum Co.) Detonation meter.
2,621,199 (Ethyl Corp.) Production of lead alkyls.
2,621,200 (Ethyl Corp.) Liquid ammonia process for forming hydrocarbonlead compounds.
2,621,475 (Phillips Petroleum Co.) Operation of multistage combustion gas turbines using inert diluent gas in fuel.
2,622,018 (Socony-Vacuum Oil Co.) Motor fuel containing amine condensation product.

Airetool ball bearing motor with single expansion cutter head for cleaning straight tubes. Motor is slip-fit constructed, and has front and rear ball bearing thrusts.

Airetool direct drive condenser cleaner. Cleans straight tubes ⅜" to 1½" I.D. Air or steam driven. Removes all scale deposits regardless of condition.



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(To obtain more data on advertised products see page 280)

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regardless of the source. Chlorination helps reduce slime in process or cooling water.

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Patents

2,622,093 (Ethyl Corp.) Recovery of tetraalkyllead.
2,622,971 (California Research Corp.) Amino phenols as rich mixture additives.
2,622,973 (Standard Oil Development Co.) Method for gasifying solid fuels.
2,623,816 (Hydrocarbon Research, Inc.) Method for the production of high heating value fuel gas.
2,623,817 (Standard Oil Development Co.) Production of fuel gases.

Lubricants

2,620,301 (Standard Oil Co.) Grease compositions containing guanidine salt and sulfonate.
2,620,302 (California Research Corp.) Lubricating oil compositions comprising 1, 2-polyalkylene glycol polymers, etc.
2,620,303 (California Research Corp.) Mercaptothiazines as sulfur-corrosion inhibiting agents in lubes.
2,620,304-9 (California Research Corp.) Lubricant containing polyalkylene glycol polymer and solubilizing agent.
2,620,345 (Mallinckrodt Chemical Works) Aluminum soaps of plurality of acids.
2,620,353 (Standard Oil Development Co.) Synthetic oil-soluble alkyl diphenylalkane sulfonates.
2,620,365 (Standard Oil Co.) Synthetic lubricating oil from alpha olefins.
2,621,158 (Sinclair Refining Co.) Lubricant containing P-S compound.
2,621,159 (Shell Development Co.) Metal working lubricant containing wax and olefin polymer.
2,621,172 (Sinclair Refining Co.) Compositions of matter from sulfur chlorides, bicyclic terpenes, phosphorus sulfides, and alkylated phenols or alcohols.
2,622,066 (Socony-Vacuum Oil Co.) Lubricant antifoamant containing dihydroxy reaction product.
2,622,067 (Socony-Vacuum Oil Co.) Emulsifiable oil compositions containing polyalkylene polyamine reaction product.
2,622,092 (Socony-Vacuum Oil Co.) Oil-soluble polyvalent metal salts of acids from oxidized hydrocarbons and process of making same.
2,622,094 (Socony-Vacuum Oil Co.) Method of purifying a synthetic lubricating oil feedstock with zinc halides.
2,622,112 (Shell Development Co.) Production of aromatic hydrocarbon lubricating oil.
2,622,993 (Deering Milliken Research Trust) Process of lubricating metal surface with metal sulfide etc.
2,623,016 (Union Oil Co. of Calif.) Lubricating oil composition containing sulfonate and weak metal salt.
2,623,017 (Phillips Petroleum Co.) Gel-type lithium grease.
2,623,018 (Standard Oil Development Co.) Extreme pressure lubricant containing dialkyle-ter of diglycol carbonate.
2,623,019 (General Electric Co.) Lubricating oils containing polysiloxane.
2,623,852 (Shell Development Co.) Water-resistant oil composition (grease).
2,623,853 (Shell Development Co.) Grease compositions containing base exchange clay.
2,623,854 (Standard Oil Development Co.) Lubricating grease compositions, containing soap of oxy acid.
2,623,855 (Shell Development Co.) Lubricating compositions containing alkyl phenol and sulfurized wax olefin.

Specialties

2,620,291 (Sun Oil Co.) 1,2,3,4-Tetrachlorobutane as a black carpet beetle larvacide.
2,622,105 (Ethyl Corp.) Process for manufacture of benzene hexachloride.
2,623,811 (J. M. Huber Corp.) Process for producing carbon black and valuable by-product gases.
2,623,831 (Standard Oil Development Co.) Ethylene diamine condensates as antistripping agents for asphalts.
2,623,862 (Phillips Petroleum Co.) Gray tower polymer rubber reclaiming solvents.
2,623,887 (Standard Oil Development Co.) Rust inhibiting composition (sorbitan ester)

EQUIPMENT

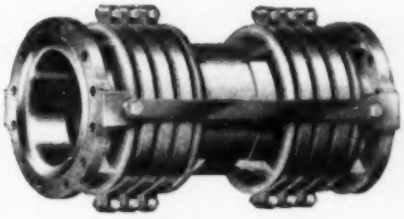
Processing, general

2,619,810 (Union Carbide and Carbon Corp.) Low pressure process of and apparatus for separating gas mixtures.
2,620,175 (Phillips Petroleum Co.) Pebble heater apparatus.

(*To obtain more data on advertised products see page* 280)

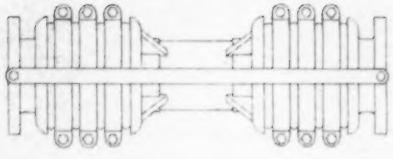
FOR LEADERSHIP

IN EXPANSION JOINTS

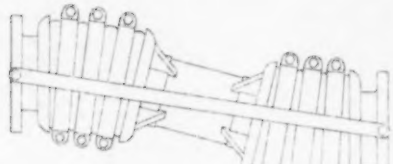


Corruflex Packless Swing Joint

Swing with ADSCO



1. *Swing Joint in normal position*



2. *Swing Joint absorbing lateral motion*

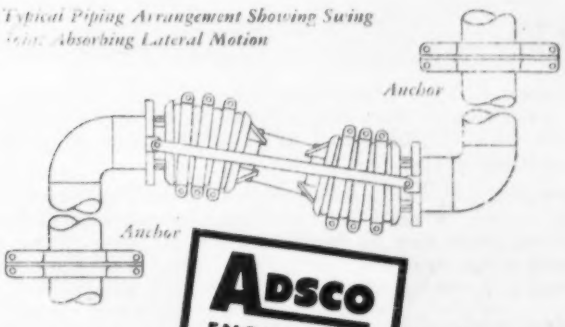
3. *Swing Joint absorbing angular rotation*

ADSCO... leading the field in expansion joints... because only ADSCO makes a complete line. This is important to you, for no other manufacturer can offer an impartial recommendation between slip and packless joints. ADSCO does not have to recommend the wrong joint simply because it does not make the right one. ADSCO *makes* the right one and can sell exactly what you need.

The Corruflex Packless Swing Joint described on this page is an illustration of the completeness and thoroughness of ADSCO's line. Here is a joint engineered for special piping conditions. In piping arrangements where normal anchoring is impossible, as in elevated pipe lines, the Swing Joint absorbs lateral motion as shown in Drawing 2 or angular rotation as shown in Drawing 3. In the Swing Joint, the bars absorb the thrust of the line.

Whatever the problem, there is a specific ADSCO joint to solve it. Call an ADSCO representative or write for further details.

Typical Piping Arrangement Showing Swing Joint Absorbing Lateral Motion



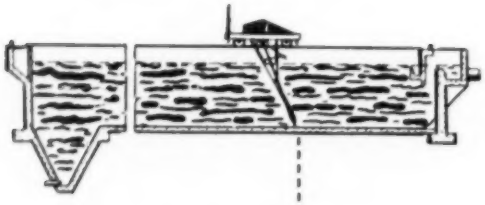
ADSCO ENGINEERED PRODUCTS

EXPANSION JOINTS
HEAT EXCHANGERS
STEAM TRAPS
STRAINERS
SEPARATORS
METERS

AMERICAN DISTRICT STEAM COMPANY, INC.

NORTH TONAWANDA, NEW YORK

Since 1877



OIL-WATER SEPARATORS FOR REFINERY WASTE

This photograph shows a typical Hardinge Oil-Water Separator operating in a west coast refinery waste water disposal plant. It is removing floating oil and solids from 107,000 barrels of oil daily at a total operating cost of .0012 cents per gallon.

The separator, (also called a Rectangular Clarifier), consists of a 57′ x 150′ rectangular tank, spanned by a traveling carriage, equipped with skimmer and scraper, which skims the floating oil from the water surface and removes the settled sludge from the tank bottom. More than thirty such Hardinge Separators are now operating in oil refineries in the U.S.A.

HARDINGE
COMPANY, INCORPORATED

YORK, PENNSYLVANIA—240 Arch St. Main Office and Works

NEW YORK 17 • SAN FRANCISCO 11 • CHICAGO 6 • HIBBING, MINN. • TORONTO 1
122 E. 42nd St. 24 California St. 205 W. Wacker Dr. 2016 First Ave. 200 Bay St.

Patents

2,620,263 (R. L. Macklin, J. M. Clark) Apparatus for fractional separation of crystalline solids.
2,621,032 (Koppers Co., Inc.) Gas scrubber provided with rotary spraying device and indicator.
2,621,105 (Phillips Petroleum Co.) High-temperature solid material-fluid contact apparatus of pebble heater type, and method of operation.
2,621,150 (Fernando M. Mora, Buenos Aires, Argentina) Apparatus and method for thermolytic decomposition of heavy liquid hydrocarbons.
2,622,114 (Phillips Petroleum Co.) Fractional crystallization apparatus and process.
2,622,205 (Ethyl Corp.) Apparatus for chlorination reactions.
2,622,794 (Sharples Corp.) Centrifugal separator.
2,622,796 (Westfalia Separator A. G., Oelde, Westphalia, Germany) Counter current extraction centrifuge.
2,622,795 (The Black-Clawson Co.) Centrifugal separator.
2,622,850 (Shell Development Co.) Matrix for heat regenerator.
2,622,853 (Universal Oil Products Co.) Heat exchanger.
2,622,968 (Standard Oil Development Co.) Contacting plate for liquid-liquid extraction tower.
2,622,969 (Universal Oil Products Co.) Recuperative autothermic reactor.
2,623,813 (Universal Oil Products Co.) Tower and internals for liquid-liquid contacting.
2,623,815 (Standard Oil Development Co.) Apparatus for gasifying carbonaceous fuel.
2,623,842 (Phillips Petroleum Co.) Hydrocarbon conversion process and reaction chamber for pebble heater apparatus.

Catalytic Reactors

2,620,262 (Stanolind Oil & Gas Co.) Contacting and heat exchanging apparatus for synthesis from hydrogen and carbon monoxide with fluidized catalyst.
2,620,967 (Lummus Co.) Gas ejector for a catalyst regenerator.
2,621,113 (Universal Oil Products Co.) Catalytic conversion unit of the fluid type.
2,622,935 (Phillips Petroleum Co.) Solid catalyst injection apparatus.
2,622,937 (Standard Oil Co.—Indiana) Electromagnetic apparatus for protecting piping and associated equipment from erosion caused by fluidized solids.
2,622,970 (Standard Oil Development Co.) Catalytic apparatus for hydrocarbon synthesis.

Valves & Fittings

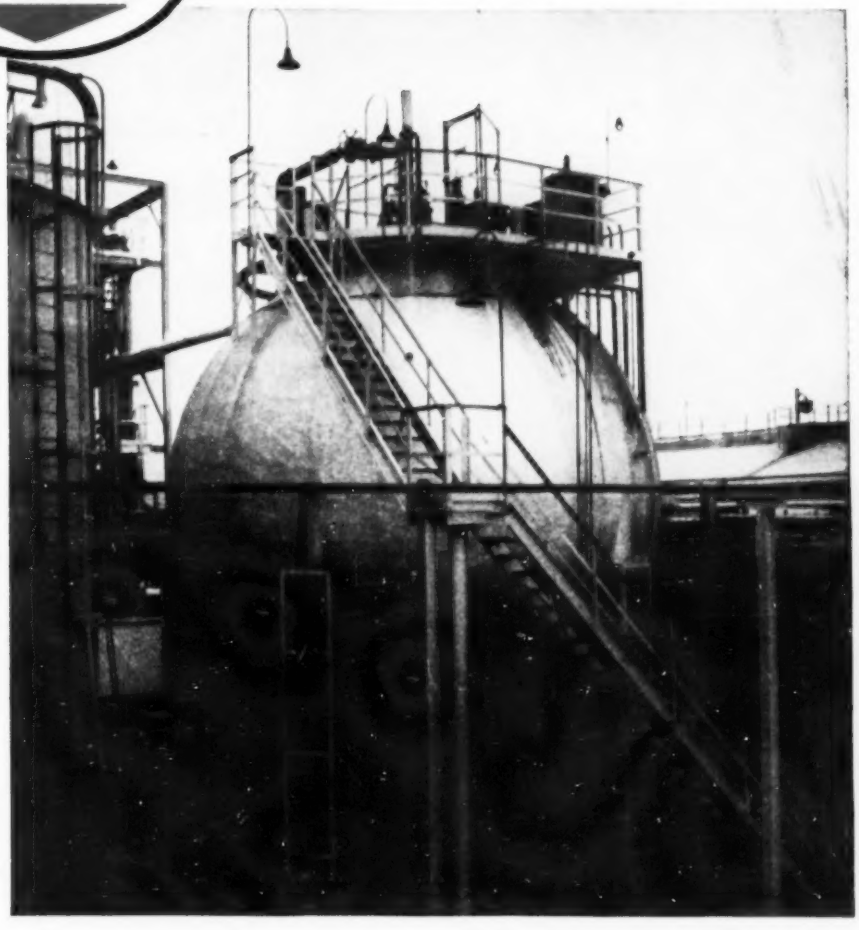
2,619,777 (Charles M. Bailey Co., Inc.) Pressure reducing valve.
2,619,983 (Fisher Governor Co.) Universal diaphragm valve.
2,620,816 (Donald G. Griswold) Backflow prevention device.
2,621,014 (Bridgeport Brass Co.) Valve for distributing or dispersing fluids in small particles.
2,621,016 (Edward Valves, Inc.) Valve construction.
2,621,888 (Cameron Iron Works, Inc.) Rotary plug valve seat.
2,621,889 (Grove Regulator Co.) Expansible sleeve type valve.
2,622,619 (Grove Regulator Co.) Flexible tube valve with liquid link connected operator.
2,622,620 (Grove Regulator Co.) Fluid pressure controlled flexible tube valve.
2,622,622 (General Controls Co.) Fluid control valve with electro-magnetic operator.
2,622,838 (John H. Stevenson) Globe valve.
2,622,849 (American Locomotive Co.) Gate valve.
2,622,886 (Yarnall-Waring Co.) Steam trap.
2,623,542 (Dole Valve Co.) Pilot operated diaphragm valve.
2,623,543 (Wm. F. Heinisch) Diaphragm operated valve with frictionless seal between diaphragm mechanism and valve.

Pumps & Compressors

2,619,910 (Robert H. Brown) Centrifugal pump.
2,620,734 (Milton Roy Co.) Constant delivery pump.
2,620,735 (Guillermo Federico Baez, Buenos Aires, Argentina) Rotary turbine pump.
2,620,968 (Hans Robert Nilsson, Stockholm, Sweden) Machine of the screw compressor type.

SOHIO

another leading refiner who desalts with PETRECO



The Standard Oil Company of Ohio is a long-time user of Petreco Electric Desalting. Like many other oil industry leaders, Sohio installed a Petreco desalting plant in one refinery, then repeated with Petreco in another.

The merit of a refining process often can be appraised by the caliber of the refining organizations who install, use and re-order. Petreco invites you to check into the large number of leading refiners who, like Sohio, use Petreco Electrospheres.

For descriptive literature and complete information on Petreco desalting, call or write

PETROLITE CORPORATION
PETRECO DIVISION

3202 South Wayside Drive, Houston 1, Texas
1390 E. Burnett Street, Long Beach 6, California

PETRECO
ELECTRIC PETROLEUM PROCESSING

CRUDE OILS: REMOVAL OF SALTS, SOLIDS, OTHER IMPURITIES; DEHYDRATING
DISTILLATES: ACID TREATING; CAUSTIC TREATING; DOCTOR TREATING
FUEL OILS: DESAPONIFICATION, ASH REMOVAL

FR 52-4

Terrific! is the word for

"Automatic" SPRAY Sprinklers

TERRIFIC . . . That's the word that insurance underwriters use in describing the new "Automatic" SPRAY Sprinkler.

It's a "Sure Fire Killer", designed for quick action and maximum effective distribution of water.

Property owners get protection-PLUS in all types of buildings with this vastly improved fire fighter that can be installed on both exposed and concealed piping systems. And . . . "Automatic" SPRAY Sprinklers are easily interchangeable with obsolete devices . . . cost no more than old style sprinklers.

This important advancement in the science of fire safety is further reason why "Automatic" Sprinkler is universally recognized as FIRST IN FIRE PROTECTION!

New literature available on request

"Automatic" Sprinkler

CORPORATION OF AMERICA · YOUNGSTOWN, OHIO

OFFICES IN PRINCIPAL CITIES OF NORTH AND SOUTH AMERICA

Patents

2,620,969 (Fluor Corp.) Compressor plant pulsation dampening system.
2,621,600 (Harry E. La Bour) Centrifugal pump.
2,621,601 (Minor W. Stout) Centrifugal pump assembly.
2,621,603 (Julian B. Thomas) Positive displacement rotary pump.
2,621,604 (G. F. Martin, Peter A. Battaglia) Rotary pump.
2,621,606 (Sundstrand Machine Tool Co.) Pump.
2,621,607 (G. J. Trapp, Leamington Spa, England) Pump.
2,621,852 (Pietro Pisa, Rome, Italy) Spherical rotary compressor.
2,621,853 (Kay Emil Bollerup, Virum, Kongens Lyngby, Denmark) Rotary compressor.
2,622,534 (James P. Johnson) Gear pump.
2,622,538 (Henri Charles Gustave Vincent, Renans, Switzerland) Rotary pump of the sliding vane type.

Instruments

2,619,830 (Phillips Petroleum Co.) Detonation meter for internal combustion engines.
2,620,660 (Atlantic Refining Co.) Liquid level gage.
2,620,665 (The British Iron and Steel Research Ass'n., London, England) Sensitive manometer.
2,620,819 (Julian A. Campbell) Liquid level control system.
2,620,933 (United States of America, as represented by the Secretary of the Interior) Solids level control.
2,621,224 (Physicists Research Co.) Mechanical-electrical displacement converter.
2,621,240 (Koppers Co., Inc.) Liquid level control and indicator.
2,621,297 (Illinois Testing Laboratories, Inc.) Apparatus for measuring vapor content of gas.
2,621,298 (Minneapolis-Honeywell Regulator Co.) Control system for a spectrograph.
2,621,299 (Combustion Control Corp.) Flame failure safeguard.
2,621,482 (Harold W. Meade) Pressure-operated mechanism for controlling fluid flow.
2,621,515 (Joseph B. Meriam) Proportional flow metering device.
2,621,517 (The Liquidometer Corp.) Resonance type capacitance responsive gage.
2,621,518 (The Liquidometer Corp.) Electric liquid level gage.
2,621,519 (Taylor Instrument Cos.) Temperature compensated thermometer.
2,621,520 (Erie Radin, Norrkoping, and Helge Ryde, Smed latten, Sweden) Sampling tube.
2,621,671 (Leeds & Northrup Co.) Electrolytic titrimeter.
2,622,015 (Douglas Pole Welman, Manchester, England) Automatic gas recorders.
2,622,062 (Tide Water Associated Oil Co.) Apparatus for automatic collection of liquid fractions.
2,622,441 (The Sperry Corp.) Internal combustion engine power analyzer.
2,622,442 (Phillips Petroleum Co.) Apparatus for measuring liquid levels.
2,622,967 (Union Carbide and Carbon Corp.) Automatic gas ratio sampling device.
2,623,179 (General Electric Co.) Mass spectrometer.
2,623,384 (Gulf Research & Development Co.) Bearing and lubricant tester.
2,623,390 (Shell Development Co.) Differential hydrostatic pressure type indicator.
2,624,014 (Dow Chemical Co.) Refractometer.

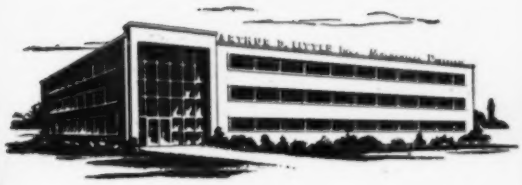
Gaskets & Seals

2,620,207 (A. R. Wilfley & Sons, Inc.) Gland-less seal for centrifugal pumps.
2,621,087 (Dresser Operations, Inc.) Rotating shaft seal means.
2,622,902 (Jonkopings Mekaniska Werkstads Aktiebolag, Jonkoping, Sweden) Sealing mechanism for vertical axis centrifugal pumps.
2,622,943 (Universal Oil Products Co.) Bearing and seal device for stirrer shafts.
2,623,764 (T. & T. Vicars Ltd., Earlestown, England) Sealing gland for rotary shafts.

Miscellaneous

2,620,830 (Herman Schultz) Self-sealing tube insert for condensers and the like.
2,622,765 (Emil Greiner Co.) Microburet or pipet.
2,623,285 (Sam G. Marinovich) Pipe-cutting machine.

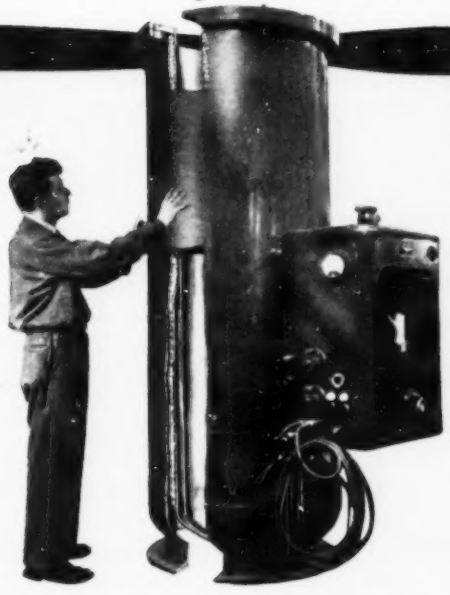
(*To obtain more data on advertised products see page* 280)



New ADL Mechanical Division Building

UNIQUE PROTOTYPE DEVELOPMENT

. . . using advanced Engineering Techniques



Design and construction of 400 gallon capacity vessels to contain liquefied gases near 400 degrees below zero F was a recent example of ADL prototype development.

Reducing costly evaporation losses took high-vacuum insulation at a pressure of 1 x 10^{-6} mm Hg, as well as knowledge in extreme low temperature engineering — even under severe transportation heat leaks of only 1/12 watt/sq. ft. occurred.

ADL experience in many areas of science and engineering produced this unique prototype.

IF lack of personnel has halted development of your new ideas or new products, the ADL Mechanical Division can take over and bring them to complete maturity.

Arthur D. Little, Inc., has blended its scientific and engineering skills in the Mechanical Division to provide industry with a unique service . . . prototype development of equipment requiring a high level of engineering. Scientists in the fields of chemistry, physics, metallurgy, mathematics, biology, electronics and technical economics can be called on as required.

Our staff is experienced in interpreting the ideas of industry and following through with the perfection of specialized equipment.

THERMODYNAMICS · HEAT TRANSFER · REFRIGERATION TO MINUS 456 F · VACUUM ENGINEERING · GAS LIQUEFACTION · ELECTROMAGNETISM · MECHANICAL DESIGN · VIBRATION

Write for Brochure PP 16-1

MECHANICAL DIVISION

Arthur D. Little, Inc.

CREATIVE TECHNOLOGY SINCE 1886

ADL Mechanical Division

30 MEMORIAL DRIVE, CAMBRIDGE, 42, MASS.

How INCO HIGH-TEMPERATURE ENGINEERS SEEK THE ANSWER TO A PROBLEM

Inco High-Temperature Service is ready to assist you on metal problems at high heat with all its knowledge of high-temperature metal performance.

High-Temperature Test Racks are supplied in different styles or shapes when necessary for placing in the corrosive atmosphere. All are basically a selection of *different* metals — which are exposed simultaneously to the corrosive conditions.

In laboratories at Bayonne, N. J., and Huntington, W. Va., creep tests measure the load-carrying ability of various alloys at temperatures up to 2100°F.

Other tests are constantly adding to the knowledge of how metals behave under varying degrees of heat and corrosive conditions. These laboratory studies are extended by field work. Investigation of metals serving in high-temperature applications reveals why some metals stand up where others fail. Corrosion is often the most important cause of damage and failures.

In field work Inco Engineers make use of High Temperature Corrosion Test Racks, shown above, to observe the effects of corrosive atmospheres. These carry a selection of different alloys which are placed right in the existing equipment to give a direct comparison of the various materials under actual service conditions.

After removal, the samples of various alloys are examined. The suitability of the alloys or the degree of damage is evaluated from the appearance of scale, the depth of attack, and other data derived from metallographic study and mechanical testing.

In your high-temperature problems, whether in present activities or in new projects, Inco High-Temperature Engineers will be glad to work with you. Let them send you the High-Temperature Work Sheet . . . to aid you in explaining your problem. Then see if Inco Engineers cannot help solve your difficulty.

Send for your copy of this new High-Temperature Work Sheet; it simplifies gathering the full story of your problem.

EMBLEM OF SERVICE

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

PERSONALS

Charles B. Duke, who joined Sun Oil Co. as a yield clerk at the Marcus Hook refinery in 1934, has been appointed manager of refinery supply and distribution division of the manufacturing department, succeeding Donald Lincoln who died in December.

Mr. Duke

Edwin H. Sampson, Jr. has been appointed assistant manager of the division in charge of supply, and **Wirt R. Robinson** assistant manager in charge of distribution.

Duke served in the manufacturing department from 1936 to 1947, when he was advanced to special assistant in the supply and distribution division. Prior to joining Sun, he worked for a number of Philadelphia banks. He is a native of Norwood, Penna., and a member of the API.

Sampson joined the firm in 1931 at Marcus Hook in the yield department. A native of Eddystone, Penna., he was with Sun Shipbuilding and Dry Dock Co. prior to coming with Sun. Robinson, a native of Atlanta, Ga., joined Sun in 1933. Before that he was vice president of the Ediplate Corp., a company formed to manufacture a seamless metal float he had patented.

* * *

Prof. Robert W. Schiessler, director of American Petroleum Institute's Project 42 at Penn State College, will receive the $1,000 Precision Scientific Co. Award in Petroleum Chemistry at the American Chemical Society's 123rd national meeting in Los Angeles, March 16.

Much of Dr. Schiessler's recent work has been on synthesizing and determining the properties of hydrocarbons. Project 42 is concerned with pure hydrocarbons in the lubricating oil range. The award is given "to recognize, encourage, and stimulate outstanding research achievements in the field of petroleum chemistry in the United States and Canada."

Director of Project 42 since 1947, Dr. Schiessler has been on the Penn State faculty since 1942. He was graduated from that school in 1939, received an M. Sc. from McGill in 1941 and his Ph. D. from Penn State in 1944. He is active in ACS matters and is the author of an ACS monograph on hydrocarbon synthesis.

Previous winners of the Award, which was established in 1948, include Dr. Bruce H. Sage, professor of chemical engineering at California Institute of Technology; Dr. Kenneth S. Pitzer, dean of the College of Chemistry at University of California and former director of research for AEC; and Dr. Louis Schmerling and Dr. Vladimir Haensel, both of Universal Oil Products Co.

* * *

S. W. Adey, London, manager of Anglo-Iranian Oil Co.'s Middle East Division, Refineries Dept., is superintending the planning and construction of its 100,000 b/d refinery at Aden, on the Red Sea, in Saudi Arabia. He has been with the company since 1923, spending 14 years at Abadan, finally becoming Works Manager. In 1937 he was transferred to the Refinery Engineering Branch at London. He served the Ministry of Fuel and Power during the war, was transferred to the company's New York office and in 1948 returned to England as manager of the Refinery Engineering Branch.

Mr. Adey

Mr. Sheldrake

R. Hedley Sheldrake, resident manager of the Aden refinery project, joined Anglo-Iranian in 1944, in an engineering capacity in the home office. He went to Haifa in 1947, and later to Abadan, subsequently taking charge of projects in Iceland and Scotland.

The Aden refinery program includes constructing a port which will accommodate tankers bringing crude from the Persian Gulf. The plant will include two atmospheric distillation units, Platforming unit, sulfur-dioxide extraction unit and power station. Some 300 British and 50 American technicians, many living on a liner anchored off Aden, are expediting the construction work.

* * *

James O. Harris, a research chemist at the Nitro, W. Va., laboratory of Monsanto Chemical Co.'s organic chemicals division since 1950, has been named a research group leader there. Dr. Harris came to the company in 1943 as a chemist in the phosphate division. A graduate of Carson-Newman College, he received his M.A. and Ph. D. in chemistry from the University of Tennessee.

Carol Eberhart, secretary to the supervisor of processing at The Texas Co., New York City, has been nominated as "first lady" of the petroleum industry by the Desk and Derrick Club of New York, Inc.

A "Woman of Achievement" to be honored for outstanding accomplishments in the oil industry at the International Petroleum Exposition in Tulsa next May 14-23, will be named by the Association of Desk and Derrick Clubs of North America, whose members are women employed in the petroleum industry.

Winner of the contest will receive an expense-paid trip to the oil show and honored at a banquet during the affair.

Miss Eberhart, who has been with The Texas Co. for 21 years, was instrumental in organizing the D&D club in New York City in the fall of 1951 and served as its first president.

* * *

The research, application and services activities of the Research and Engineering Department of Ethyl Corp. have been realigned, to create a stronger organization for carrying out both customer service and research in the fuel additive field. In place of five divisions at the company's research laboratories in Detroit, three major divisions will operate under **J. B. Macauley,** Director of Research.

Mr. Scales

Mr. Lovell

Mr. Guy

The Product Application Division will be headed by **Richard K. Scales** as director. The Automotive Products Research Division will be directed by **Wheeler G. Lovell.** The Chemical Research and Development Division will continue to function essentially unchanged under **George Kirby,** both at Detroit and at the manufacturing center at Baton Rouge, La.

The Product Application Division

has two main sub-divisions; Technical Service, with **Dan M. Guy** as director and Engineering Research headed by **Harold Gibson.** The two main research groups of the Automotive Products Research Division are: Additives and Deposits, under **Hymin Shapiro** and Engine Combustion Research, headed by **Howard Hesselberg.**

• • •

Eugene Holman, president of Standard Oil Co. (N. J.), has been named as one of four new vice-chairmen of the Dept. of Commerce's Business Advisory Council. **Leonard F. McCollum,** president of Continental Oil Co., has been elected as one of five new members of the Council.

• • •

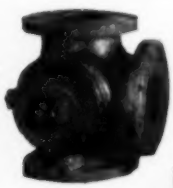
William P. Gage was named president and a director of Grace Chemical Co., New York, on Feb. 1. He has been vice president in charge of manufacturing for Shell Chemical Corp. since 1941. Grace Chemical, organized in 1952, is engaged in construction of its first manufacturing unit, a $20 million nitrogen plant, near Memphis, Tenn.

Mr. Gage joined Shell Oil Co. in 1929 at the research laboratory, Wood River, Ill., later serving as head of the gas department and assistant superintendent of the Houston refinery. Still later he was appointed head of research and development for Shell in New York before transferring to Shell Chemical.

• • •

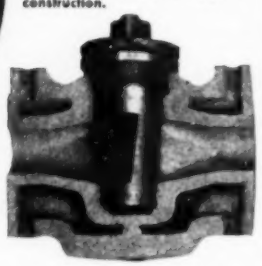
New president of the American Institute of Chemical Engineers is **Wm. T. Nichols,** director, general engineering dept., Monsanto Chemical Co., St. Louis. He succeeds **W. I. Burt,** vice-president, manufacturing, B. F. Goodrich Chemical Co., Cleveland. **Chalmer G. Kirkbride,** president and director of Houdry Process Corp., Philadelphia, was elected vice-president. **Stephen L. Tyler,** executive secretary and **C. R. DeLong,** treasurer, both of New York, were re-elected.

Four new directors also were chosen by the AIChE; they are: **Eger V. Murphree,** president of Standard Oil Development Co., New York; **George G. Oberfell,** consultant and retired vice-president of Phillips Petroleum Co., Bartlesville; **Wm. T. Nixon,** manager, design division, engineering and construction dept., The Atlantic Refining Co., Philadelphia, and **Lee Van Horn,** vice-president for research and development, The Fluor Corp., Ltd., Los Angeles.



At left: Jacketed 3-Way Plug Cock.

Below: Cutaway section of Jacketed Cock, showing packing gland construction.



H&B ESTABLISHED 1907

Jacketed Pipe, Pumps, Valves and Fittings . . .

Jacketed Meter, with set-back register, for measuring viscous liquids.

for maintaining uniform temperatures (hot or cold) in process pipes

Regardless of whether the material is being heated or cooled in the processing, and what heating or cooling medium is being used, H & B jacketed fittings are available for all applications. Steam, hot water or hot oil may be used for heating, cold water or brine for cooling.

H & B can save you money on your jacketed pipe and fitting requirements because we buy all standard size pipe from the mill in carload lots, make our own special flanges in quantities, and are tooled up for making jacketed equipment at lowest possible price. Write for Bulletin J-50.

HETHERINGTON & BERNER INC.

751 KENTUCKY AVE. INDIANAPOLIS 7, IND.

Two long-service supervisory personnel have retired from the General Petroleum Corp.

W. M. Manley retired after more than 40 years in refinery and production operations with the company and its affiliates. With General Petroleum since 1913 when he was employed as a stillman at the Vernon refinery, he has held the post of assistant superintendent at the Torrence refinery since 1945. A native of Denver, Col. he is a member of the Foreman's Club of Los Angeles.

Lloyd H. Mathews, electrical superintendent at Vernon, has held that post since 1947. Before that time, he was engaged in production department operations in the San Joaquin area. A native of Santa Ana, Calif., his service with the company started in 1919.

• • •

William F. Thiede, general manager of the East Coast Manufacturing Division, Esso Standard Oil Co., at Bayway, has been appointed assistant general manager of Esso's over-all manufacturing operations at New York, succeeding **Paul E. Kuhl,** on leave of absence with the PAD. Mr. Thiede's appointment was effective Jan. 1.

Harold G. Mangelsdorf, who has been general superintendent at Bayway, will succeed Mr. Thiede as general manager of the East Coast Manufacturing Division. Other changes at Bayway include:

Daniel L. Hussey, formerly assistant general superintendent, to general superintendent succeeding Mr. Mangelsdorf; **Claude I. Bigelow,** head of the refining division, to process superintendent; **Daniel T. Gregg,** technical assistant, pressure distillation department, to head of the refining division, and **Everett F. McTernan,** formerly process superintendent, to special assistant to the process superintendent.

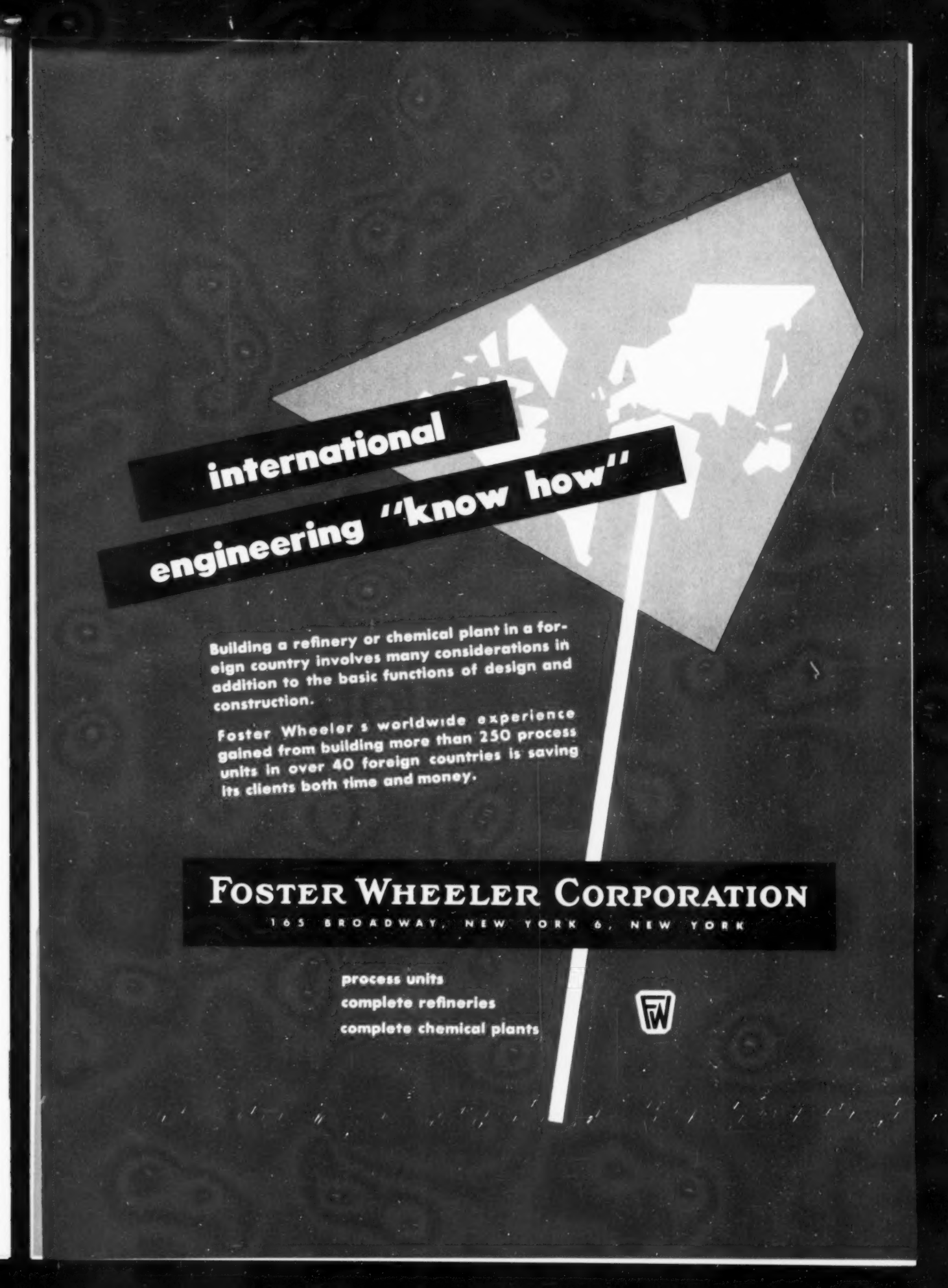
• • •

B. L. Ray, A. Bruce Boehm and **J. P. Warner** are new directors of Enjay Co., petrochemicals marketing subsidiary of Esso Standard Oil Co. Ray and Boehm replace **L. E. Ulrope** and **E. H. Collins,** while Warner's is a newly-created directorship. Ray is director and assistant general manager of marketing for Esso; Boehm is Enjay's assistant general sales manager, and Warner is general superintendent of Esso's Baton Rouge refinery.

• • •

John A. Brooks has been appointed group leader in the pilot plant division of the Whiting, Ind., research department laboratories of Standard Oil Co. (Ind.). He joined Standard in 1946 as a chemical engineer and graduated from Illinois Institute of Technology.

(*To obtain more data on advertised products see page* 280)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engineering "know how"
Building a refinery or chemical plant in a foreign country involves many considerations in addition to the basic functions of design and construction.
Foster Wheeler's worldwide experience gained from building more than 250 process units in over 40 foreign countries is saving its clients both time and money.
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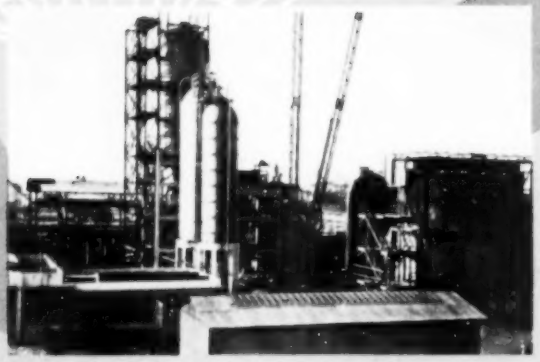
Belgium
and in the USA

France



Catalytic cracking and other units under construction in France.

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Complete engineering facilities at New York, Paris, London, St. Catharines, Ontario and Houston, Tex.

Ethyl Names Fuel Technologists

Reorganization of the fuel technology section of Ethyl Corp.'s sales department has been completed with appointment of three new regional fuel technologists, under the supervision of Jack D. Fuller as manager. Mr. Fuller, who has specialized in refinery technology work with the company since 1942, has served as central region fuel technologist for the last four years.

Mr. Fuller

The three new assignments are C. Alon Cole, eastern region at New York; Fred P. Robinson, central region at Chicago; and Martin L. Alspaugh, southern region at Tulsa. Herbert N. Peters continues in the western region at Los Angeles.

Mr. Cole, a chemical engineer from Syracuse University, was supervisor of light products operations at Socony-Vacuum Oil Co.'s Paulsboro, N. J., refinery before joining Ethyl last September. Mr. Robinson, a chemical engineer from Purdue, joined the firm in 1946 and was manager of the gasoline testing laboratory at Yonkers, N. Y., before his new assignment. Mr. Alspaugh, chemical engineer from Oklahoma A & M, has been with Ethyl 16 years and served as a research engineer at the Detroit laboratories before coming to the fuel technology section.

Petreco Expands Research

Petreco Division of Petrolite Corp. has completed an addition to their research facilities at the Webster Groves, Mo., laboratories. It includes approximately 4500 sq. ft. of floor space in a new, two-story, reinforced concrete and brick building.

The structure will contain facilities for fundamental investigation of electric fields and for study of the chemical phases of the various electric treatment processes developed by the company. The expansion was necessitated by Petreco's growing programs of work in the field of electric petroleum processing.

New Engineering Firm Set Up

Stracho Engineering Corp., a new engineering firm, has established headquarters in Shreveport, La., to serve the petroleum, chemical, power, and allied industries in process piping and welding. Principals are A.M. Croswell, who will serve as executive vice president, and Walter S. Rae, Jr., vice president and chief engineer. Offices are in the First National Bank Bldg.

Croswell has for the past two years been welding and project engineer for Gulf Southern Contractors on the 1200-mile pipe line expansion program of United Gas Pipe Line Co. Rae, since 1950, has been design engineer in the design development dept. of A. O. Smith Corp., Milwaukee, Wis.

Stracho will offer services in welding research, procedure control, inspection, consultation, and laboratory testing. Engineers will be available for work on compressor station, gasoline plant and dehydration plant piping; process piping in refineries; gas and oil transmission lines; chemical plant piping, etc.

B&W Promotes Metallurgists

The appointment of Harold D. Newell as consulting metallurgist and John J. B. Rutherford as chief metallurgist of the Tubular Products Div., Babcock & Wilcox Co., has been announced. Mr. Newell has been chief metallurgist since 1927. In his new post, he will be relieved of detail work in connection with the supervision of the research section of the laboratory in order to devote his time to specific metallurgical problems. With B&W since 1919, he has pioneered the development of many alloy tubing steels for use in petroleum, chemical, and power generation industries.

Mr. Newell

Mr. Rutherford

Mr. Rutherford, who has been assistant chief metallurgist, will now be in charge of the research section, process and product development, and customer service. Prior to his association with B&W in 1938, he was a metallurgist with American Chain & Cable Co. and U. S. Steel Corp. He authored the article, "Heating Tube Failures," in the January issue of PETROLEUM PROCESSING.

Kellogg Promotes Wickham

Henry P. Wickham, long associated with M. W. Kellogg's Fluid catalytic processing developments, has been selected to manage the firm's expanded Operating Division. His duties will be largely concerned with the plans to broaden technical service. The division's functions include operating and testing Kellogg-designed units before turning them over to the customer, and instructing the customer's technicians in operations.

Joseph W. Smith has been appointed general manager of construction for the company. He joined Kellogg in 1936, and since that time has been in the same department, most recently as assistant manager. Mr. Smith is a graduate of Michigan with a B.S. in civil engineering.

Clarridge Up at Taylor

Ralph E. Clarridge has been made chief engineer for Taylor Instrument Cos., replacing Karl H. Hubbard, who was made technical director, Replacing Clarridge as manager of the application engineering dept. is George E. Howard, formerly assistant manager.

Mr. Clarridge

Mr. Howard

Clarridge is a graduate of Ohio State and has been with Taylor since 1930, starting in the research dept. as a physicist. He transferred to the application engineering dept. in 1934. Howard, also an Ohio State graduate, has devoted his work in the application engineering dept. to the petroleum, chemical, and textile industries. Hubbard has been with the company since 1928, joining as a researcher and becoming head of the department in 1931. From 1938 to the present, he has served as chief engineer. In his new capacity as technical director, he will act as consultant and be responsible for the firm's research activities.

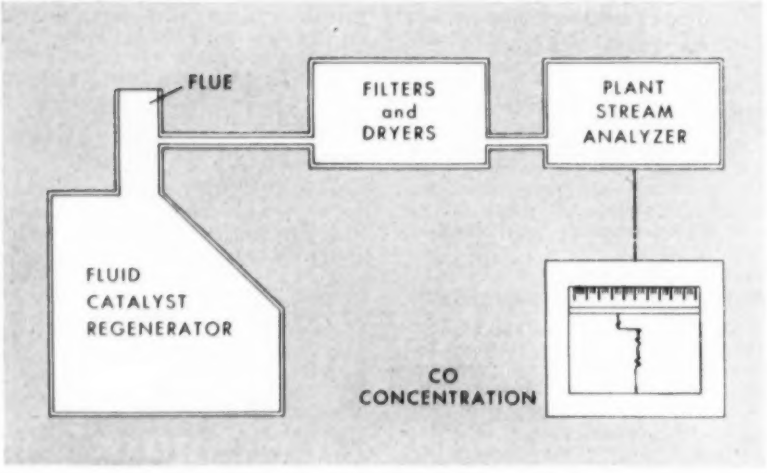
Chiksan Expands at Brea

Expansion of the Chiksan Co. plant at Brea, Calif., is now under way to increase office area and warehouse and assembly facilities. A new 28,000 sq. ft. working area will be provided when the structure is completed, immediately adjacent to the present main office building. The project is expected to be finished by July.

Fluor Sales Changes

M. A. Ellsworth, formerly vice president of the mid-continent area, has been made vice president and director of sales for Fluor Corp., with headquarters in Los Angeles. L. R. Lyon, formerly district sales engi-

AFTERBURN STOPPED
before it starts



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PLANT STREAM ANALYZER

Problem . . . Fluid cat cracking unit, operated for maximum gasoline production, falling below scheduled output.

Cause . . . Drastic readjustment of operating variables necessary to stop severe afterburning in the catalyst regenerator.

Approach . . . Continuous analysis of CO concentration in the regenerator flue gas, to provide instant and unmistakable indication of the start of burning to dioxide — minutes before the resulting afterburn could be detected by any other means.

Instrumentation . . . Baird Associates infrared type Plant Stream Analyzer, for simplicity, speed, sensitivity, and reliability under plant conditions.

Results . . . Operator used the lean-phase water sprays as soon as the Analyzer revealed the distinct warning drop in CO concentration. This permitted stabilization with only minor readjustments of operating variables. Average output rose to well above nominal rated capacity for the unit, and remained there in routine operation.

This plant-tested application can revolutionize your f.c.c. picture. Let us tell you about it in detail.

PROCESS CONTROLS
a division of Baird Associates, Inc.
11 UNIVERSITY ROAD CAMBRIDGE 38, MASSACHUSETTS

neer in Tulsa, has been appointed Tulsa sales manager.

Ellsworth, with Fluor 11 years, succeeds J. P. Wiseman, recently named president of the new Fluor Corp. of Canada. A graduate of Oklahoma A & M, Ellsworth was associated previously with M. H. Roth Co., Tulsa, and the Wheeling Steel Corp.

Schmitz Heads Crane Sales

Carl E. Schmitz, who joined Crane Packing Co. in 1942, has been appointed vice president in charge of sales. He was previously vice president and director of engineering. Well-known in engineering circles, Mr. Schmitz is a former president of the American Society of Lubrication Engineers and a member of twenty-two technical organizations.

Mr. Schmitz

In a reorganization of the sales department under Mr. Schmitz, there will be five division sales managers: E. H. Stubenrauch, mechanical packings; Stephen Hawxhurst, molded Teflon products; Harry I. Sole, lapping machines; V. E. Vorhees, mechanical seals; and Stillman Segar, plastic lead seal. Another recent appointment has been that of A. J. Solari to chief engineer of the mechanical seal division.

Riesz Heads Catalysis Studies

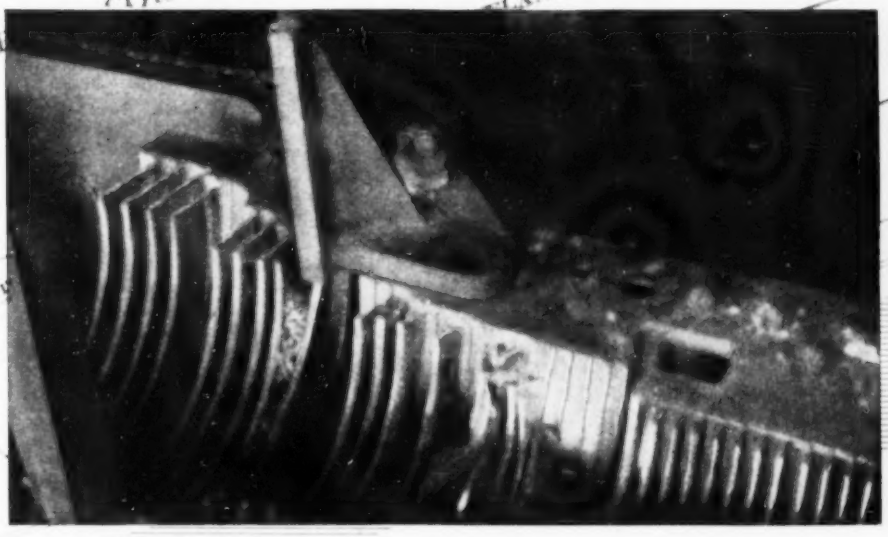
Dr. Charles H. Riesz has been named to head up an expanded and coordinated program for catalysis research at Armour Research Foundation of Illinois Institute of Technology. Prof. Vasili I. Komarewsky, director of Illinois Tech's catalysis laboratory will be consultant. Coordination of the work will be conducted through the Foundation's physical chemistry section under the supervision of Dr. John E. Barkley. Dr. Julian Glasser, research engineer in the materials and processes division, was active in establishing the new program and serves as a member of the catalysis research group.

Donald Joins National Research

Kenneth G. Donald has assumed the position of vice president and treasurer of National Research Corp., Cambridge, Mass. Mr. Donald left the post of president and director of Celanese Central, a subsidiary of Celanese Corp. of America, to join National Research. Before becoming associated with Celanese, he had been with Robert Heller Associates, a management consulting firm in Cleveland and also president and director of Jack & Heintz Precision Industries, Inc.

(To obtain more data on advertised products see page 280)

How Much Would It Cost You...



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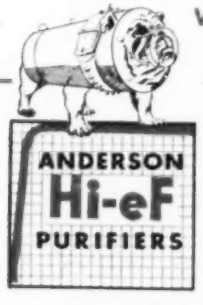
Replacement of turbines is costly . . . even in the case of minor repairs, labor, parts, and downtime costs soon mount up. To go under the assumption that the installation of superheaters in a boiler eliminates the need for purifier protection is dangerous. It did not protect this turbine which is almost a total wreck because of carry-over. Particularly during startup and periods of faulty boiler operation such as occurred above, turbines should have purifier protection.

You owe it to your plant management to insist upon protection of every turbine with a Hi-eF Purifier. These high efficiency units cost no more than ordinary separators yet assure you of the delivery of clean, dry steam of better than 99.95% quality, to your turbines. A Hi-eF Purifier removes virtually all line scale, water and mist and dirt that might build up and erode turbines, reciprocating engines and the like.

The use of Hi-eF Purifiers ahead of turbines and other steam using equipment and in boilers is a worth-while investment . . . much less than the cost of repairs and downtime. Performing at all times at high efficiency without the use of moving parts, a Hi-eF Purifier requires no maintenance. Don't chance a costly breakdown. Write, wire or phone today for information on protecting your steam-using equipment.



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Petrochemical Literature Is Topic Of Symposium at ACS Meeting

A SYMPOSIUM on "The Literature of Chemicals Derived from Petroleum" has been scheduled for March 16 and 17 during the 123rd national meeting of the American Chemical Society in Los Angeles.

Under the direction of Miss Charlotte Schaler, Sinclair Refining Co. as chairman, the symposium is being jointly sponsored by the ACS divisions of petroleum chemistry and chemical literature.

Subjects to be covered by the various speakers cover literature on basic research, commercial development, oxygen, nitrogen, and halogen concontaining derivatives, sulfur, and sources of information. The complete program follows:

Monday afternoon, March 16

Introduction — Scope of the Symposium, Charlotte Schaler.

History of the Petroleum Chemicals Industry, Richard F. Goldstein.

The Literature of Raw Materials for Production of Chemicals from Petroleum and Natural Gas, Ben H. Weil and Marshall Sittig.

The Literature of the Basic Research on Hydrocarbons Derivable from Petroleum (and Natural Gas), Albert E. Miller.

The Literature of the Commercial Development of Hydrocarbons Derivable from Petroleum and Natural Gas, Gustav Egloff, Mary Alexander, and Catherine Zimmer.

The Literature of the Oxygen-Containing Hydrocarbon Derivatives Obtainable from Petroleum and Natural Gas, Martin M. Padwe.

Tuesday morning, March 17

The Literature of Halogen-Containing Hydrocarbon Derivatives Obtainable from Petroleum and Natural Gas, Barbara Pfahler.

The Literature of Nitrogen-Containing Compounds Obtainable from Petroleum and Natural Gas, G. Malcolm Dyson.

The Literature of Sulfur Compounds Obtainable from Petroleum Fractions, J. H. Karchmer.

Sources of Information for Market Surveys on Petroleum Chemicals, Richard M. Lawrence and Raymond H. Ewell.

NGAA Regional Meeting Set for Midland Feb. 27

SAFETY, maintenance, and corrosion will come in for discussion during the one-day Permian Basin Regional Meeting of the Natural Gasoline Ass'n. of America, Feb. 27, at the Scharbauer Hotel, Midland, Texas.

Registration opens the day's activities at 8:00 a.m. The morning session starts at 9:30, under the chairmanship of W. L. Phillips, Phillips Petroleum Co., Odessa, Texas. G. E. Kendricks, El Paso Natural Gas Co., Jal, N. M., is chairman of the afternoon session, which begins at 2:30 p.m.

The meeting winds up with the usual "cooling tower" at 5:30, courtesy of Natural Gasoline Supply Men's Ass'n., and dinner at 7:00 p.m. Program details follow:

Morning Session—9:30 a.m.

Opening Remarks—NGAA President, John F. Lynch, president, La Gloria Corp., Corpus Christi, Texas.

Accident Problems and Safe Practices in Natural Gasoline Plant Operations — W. J. Rogers, Magnolia Petroleum Co., Dallas.

Yard tick for Promotion of Employes—W. C. Ford, industrial relations consultant, Houston.

Preventative Maintenance for Centrifugal Pumps—F. B. Applegate, Pacific Pumps, Inc., Huntington Park, Calif.

Afternoon Session—2:30 p.m.

What You Can Expect of Communistic Russia—Robert E. Stripling, attorney, Midland.

The Effect of Precooling Combustion Air for Gas and Diesel Engines—W. R. Crooks, Cooper-Bessemer Corp., Mt. Vernon, Ohio.

Experience in the Control of Corrosion in Cooling Water System —W. A. Tanzola, W. H. & L. D. Betz, Philadelphia, Penna.

Refining Oil for Energy—a sound motion picture in color, courtesy, Shell Oil Co.

WPRA Annual Meeting Program Taking Shape

ARRANGEMENTS are now nearing completion for the 41st annual meeting of Western Petroleum Refiners' Ass'n. in San Antonio, March 23-25, at the Plaza Hotel. Among papers to be presented during the three technical sessions are:

"Technical and Political Trends Affecting the Disposal of Refinery Wastes," by R. N. Giles, Standard Oil Co. (Indiana), Chicago, Ill.

"Underground Storage of Liquid Petroleum Products," by Douglas Ball, oil & gas consultant, Washington, D. C.

"Application of Lubricating Oil Additives," by W. D. Thomas, Jr., American Cyanamid Co., New York City.

"Effect of Fuels and Lubricants on Octane Requirement Increase," by W. E. Bettoney and J. J. Mikita, du Pont, Wilmington, Del.

Two technical session speakers who have not as yet announced the exact titles of their papers are Dr. Gustav Egloff, Universal Oil Products Co., Chicago, and A. J. McIntosh, Socony-Vacuum Oil Co., Inc., New York City.

Chairmen for the technical sessions are Dr. Wm. F. Krause, Globe Oil & Refining Co., Lemont, Ill.; C. W. Cooper, Pure Oil Co., Nederland, Texas; and L. A. McReynolds, Phillips Petroleum Co., Bartlesville, Okla.

Clarence Manion, dean emeritus of the Notre Dame Law School, will be the featured speaker during the opening general session on Tuesday afternoon, March 24. R. R. Irwin, Socony-Vacuum, Kansas City; and Bruce Brown, Pan-Am Southern Corp., New Orleans, La., will serve as chairmen of the general sessions.

Oil Man's Calendar

FEBRUARY

Instrument Society of America, New York Section, sixth annual regional meeting, Hotel Statler, New York, N. Y., Feb. 18.

Natural Gasoline Assn. of America, regional meeting, Scharbauer Hotel, Midland, Texas, Feb. 27.

MARCH

American Society for Testing Materials, Spring meeting and Committee Week, Hotel Statler, Detroit, Mich., Mar. 2-6.

American Society for Testing Materials, Committee E-14 on Mass Spectrometery, Pittsburgh Conference, Pittsburgh, Pa., Mar. 3-7.

American Institute of Chemical Engineers, Buena Vista Hotel, Biloxi, Miss., Mar. 8-11.

American Chemical Society, 123rd national meeting, Los Angeles, March 15-19.

National Assn. of Corrosion Engineers, Ninth Annual Conference & Exhibition, Hotel Sherman, Chicago, Ill., Mar. 16-20.

National Collegiate-Industry-Government Conference on Instrumentation, co-sponsored by Michigan State College, National Science Foundation, Bureau of Standards, Instrument Society of America, American Society for Engineering Education; at Michigan State College, East Lansing, Mich., March 19-20.

Western Petroleum Refiners Assn., annual meeting, Plaza Hotel, San Antonio, Texas, Mar. 23-25.

American Society for Metals, Eighth Western Metal Congress and Exposition, Pan-Pacific Auditorium, Los Angeles, Calif., Mar. 23-27.

APRIL

Assn. of Consulting Chemists & Chemical Engineers, symposium, Hotel Belmont-Plaza, New York, N. Y., Apr. 21.

American Inst. of Chemical Engineers and **Chemical Institute of Canada,** joint meeting, Royal York Hotel, Toronto, Canada, Apr. 26-29.

Natural Gasoline Assn. of America, 32nd annual convention, Rice Hotel, Houston, Texas, Apr. 29-May 1.

MAY

Eighth Purdue Industrial Waste Conference, Purdue Memorial Union Bldg., Lafayette, Ind., May 4-6.

American Petroleum Institute, Division of Refining, mid-year meeting, Hotel Commodore, New York, N. Y., May 11-14.

International Petroleum Exposition and Congress, Hall of Science, Tulsa, Okla., May 14-23.

Materials Handling Exposition, Convention Hall, Philadelphia, Pa., May 18-22.

Scientific Apparatus Makers Assn., annual meeting, The Greenbrier, White Sulphur Springs, W. Va., May 24-28.

Western Petroleum Refiners Assn., regional technical-industrial relations meeting, Hotel Broadview, Wichita, Kans., May 28-29.

JUNE

Society of Automotive Engineers, annual summer meeting, Hotels Ambassador and Ritz-Carlton, Atlantic City, N. J., June 7-12.

Exposition of Basic Materials for Industry, Grand Central Palace, New York City, June 15-19.

Western Petroleum Refiners Ass'n., regional technical-industrial relations meeting, Conrad Hilton Hotel, Chicago, Ill., June 18-19.

American Society for Testing Materials, annual meeting, Hotel Chalfonte-Haddon Hall, Atlantic City, N. J., June 29-July 3.

SEPTEMBER

American Institute of Chemical Engineers, regional meeting, Fairmount and Mark Hopkins Hotels, San Francisco, Calif., Sept. 13-16.

Instrument Society of America, 8th national exposition and instrument conference, Sherman Hotel, Chicago, Sept. 21-25.

Western Petroleum Refiners Ass'n., regional technical-industrial relations meeting, Hotel Henning, Casper, Wyo., Sept. 24-25.

OCTOBER

Packaging Institute, 15th annual forum, Hotel Statler, New York City, Oct. 12-14.

Scientific Apparatus Makers Ass'n., recorder-controller section, midyear meeting, Seaview Country Club, Absecon, N. J., Oct. 14-16.

Society of Industrial Packaging & Materials Handling Engineers, convention, Boston, Mass., Oct. 18-24.

Product Stocks at Refineries Climbing to New High Levels

THE continuing high rate of crude runs to stills of U. S. refiners will further increase their combined stocks of products, which already stand at the highest figure on record. Primary stocks of gasoline, kerosine, distillate fuels and residual fuels Jan. 24, '53 (API data) were nearly 302,000,000 bbls. This was 8% larger than their total on Jan. 26, '52, despite the interruption to plant operations caused by the strike of refinery workers last May. Current stocks are 17% larger than the total of 257,739,000 bbls. Jan. 27, '51.

In volume, total product stocks at refineries this January were nearly 23,000,000 bbls. larger than a year ago. Stocks of heating oils (kerosine and distillate fuels) were over 13,000,000 bbls. larger; gasoline stocks about 2,000,000 bbls. higher and residual fuel stocks about 7,000,000 larger. Table 1 compares total stocks by refining districts for the two periods.

In the East Coast refining district, total product inventories this January were 19% larger than a year ago. The effect of this large increase, however, is partly offset by a 11% decline in refiners' stocks in the Gulf Coast district. Combined product stocks for the two eastern seaboard refining districts are nearly 141,000,000 bbls., compared with around 133,000,000 bls. last January. Combined stocks of gasoline are about the same for the two periods (around 60,500,000 bls.). Stocks of heating oils are around 4,500,000 bbls. larger, the increase in the East Coast district more than making up a decrease in the Gulf Coast area. Stocks of residual fuels were about 2,750,000 bbls. larger this January.

In the Ind.-Ill.-Ky. refining district, combined product stocks are not much higher this January than a year ago, heating oils being about 1,800,000 bbls. larger and residual fuels about 750,000 bbls. lower.

In the Okla.-Kans.-Mo. district combined stocks are about 2,000,000 bbls. larger, due to increases in gasoline and heating oils. Residual fuel stocks are a few hundred thousand barrels lower.

In the California district, combined product stocks are around 10,000,000 bbls. larger this January. The increase is made up by about 4,500,000 bbls. in distillate stocks and 5,500,000 bbls. in residual fuels.

Heating Oil Stocks—With only a few weeks left in the period in which refiners ship heating oils for the current season, these stocks for the U. S. were 109,069,000 bbls. on Jan. 24. This was 13,657,000 bbls. higher than on Jan. 26, '52. Withdrawals this season since Nov. 1 have been 44,768,000 bbls., as compared with 50,716,000 bbls. withdrawn in the same weeks in the previous heating season.

East of California, heating oils stocks Jan. 24, 98,159,000 bbls., were 9,000,000 bbls. higher than a year ago. Withdrawals from storage this season since Nov. 1 have been 42,574,000 bls.; last season they were 47,093,000 bbls. in the same weeks. Indicated refinery yields in January were one per cent higher than a year ago.

Gasoline Stocks—Changes in refiners' inventories of gasoline follow the pattern of a year ago. U. S. stocks have built up by 25,316,000 bbls. since early November to 145,877,000 bbls. on Jan. 24, as compared with a build up of 24,068,000 bbls. to 143,621,000 bbls. on Jan. 26, '52. East of California stocks of 130,020,000 bbls. Jan. 24 represented a buildup of 23,872,000 bbls. Stocks Jan. 26, '52 of 127,652,000 bbls. included a buildup of 22,787,000 bbls. Late winter and early spring last year saw an abnormally high buildup of gasoline stocks in anticipation of the refinery strike in May. Gasoline yields on crude are running about one per cent higher than a year ago.

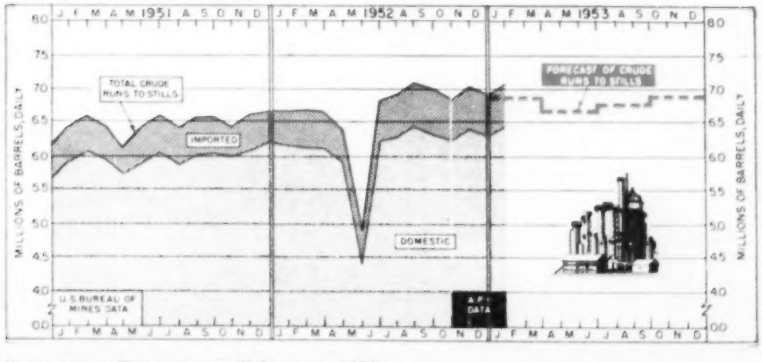
Residual Fuel Stocks—Refinery runs and yields are being held down but imports are growing due to several causes. East of California refiners' stocks late in January were only about 1,000,000 bbls. higher than the year previous. Stocks in California were 5,547,000 bbls. larger. Indicated demand for January is not much larger than a year ago.

Table 1—Refiners' Combined Stocks of Gasoline, Kerosine, Distillates and Residual Fuels, Jan. 26, '52 and Jan 24, '53

(1000 Bbls., API data)

	Jan. 26, '52	Jan. 24, '53	Change	% Change
East Coast	74,011	88,095	+14,094	19%
Gulf Coast	58,931	52,766	— 6,165	11%
Total Coastal	132,942	140,861	+ 7,919	6%
Appalachian	8,627	9,666	+ 1,039	12%
Ind.-Ill.-Ky.	56,272	57,068	+ 796	1%
Okla.-Kans.-Mo.	26,376	28,449	+ 2,073	8%
Other Inland	21,057	22,036	+ 979	5%
Total East of Cal.	245,274	258,080	+12,806	5%
California	33,716	43,786	+10,070	29%
Total U. S.	278,990	301,866	+22,876	8%

Fig. 1—Crude Runs Again Top 7,000,000 B/D



Crude Runs to Stills

Daily Average (1000 bbls.)

	Domestic	Foreign	TOTAL
Jan. '53 API*	6,447	647	7,094
Jan. '52 BM	6,190	450	6,640
Change	257	197	454
% Change	4.2	43.8	6.8

*Through Jan. 24

Total (1000 bbls.)
(Bureau of Mines Data)

12 Mos. '52*	2,234,399	206,124	2,440,523
12 Mos. '51	2,188,677	181,727	2,370,404
Change	45,722	24,397	70,119
% Change	2.1	13.4	3.0

*Dec. estimated from API data

BM Forecast of Crude Runs to Stills, 1953
(Dec. 26, 1952; 1000 b/d avg. by quarters)
1st Q., 6,920 2nd Q., 6,750 3d Q., 6,810 4th Q., 6,972

Yields on Crude Runs to Stills

	Gasoline %	Kerosine %	Dist. Fuels %	Resid. Fuels %
Jan. '53 API*	45.5	5.8	22.1	18.3
Dec. '52 API	44.3	6.1	21.9	18.5
Nov. '52 BM	43.8	5.6	21.4	18.4
Jan. '52 BM	42.9	6.2	21.6	19.8

*Through Jan. 24

Fig. 2—Gasoline Demand Drops Off in January

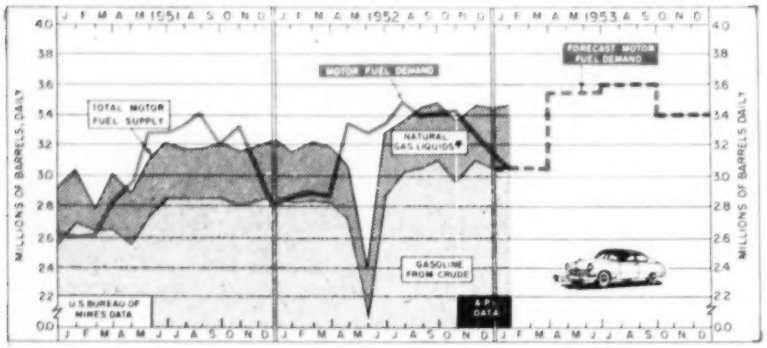


Fig. 3—"Gas" Stocks Up To 146,000,000 Bbls.

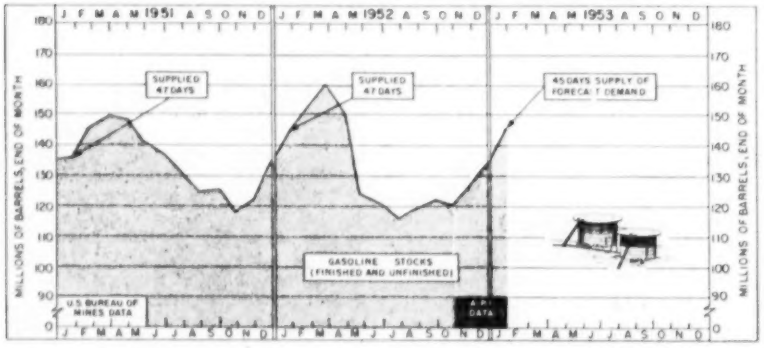


Fig. 4—Heating Oil Demand Reaches All-Time High

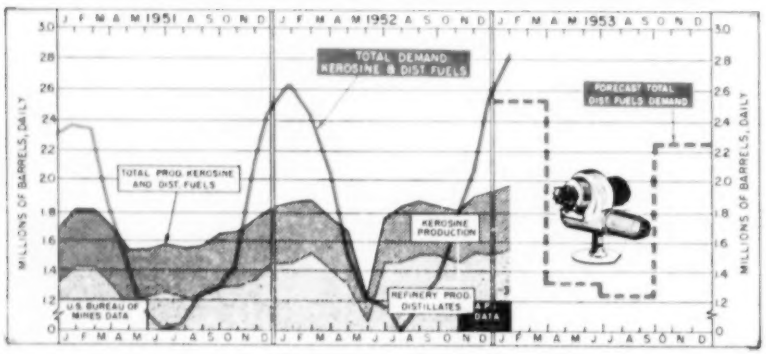
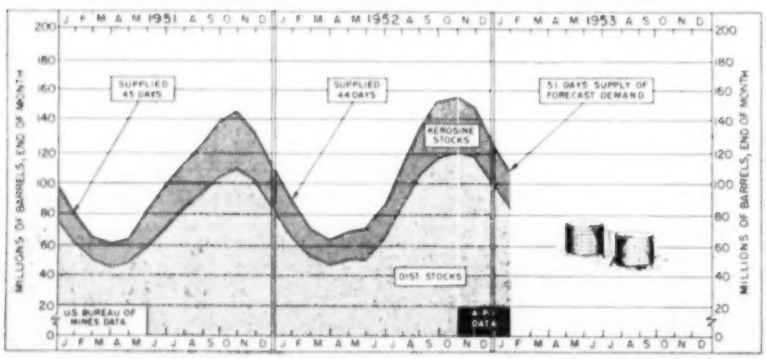


Fig. 5—51 Days' Supply of Heating Oil on Hand



Motor Fuel Supply

Daily Average (1000 bbls.)

	Gasoline from Crude	Natural Blended Used Direct	TOTAL
Jan. '53 API*	3,086	395	3,481
Jan. '52 BM	2,821	358	3,179
Change	+265	+37	+302
% Change	9.4	9.9	9.5

*Through Jan. 24

Total (1000 bbls.)
(Bureau of Mines Data)

12 Mos. '52*	1,052,370	138,766	1,191,136
12 Mos. '51	1,009,630	129,881	1,139,511
Change	+42,740	+8,885	+51,625
% Change	4.2	6.8	4.5

*Dec. estimated from API data

Motor Fuel Demand

Including Exports
Daily Average (1000 bbls.)

Jan. '53 API*	3,065
Jan. '52 BM	2,882
Change	+183
% Change	6.3

*Through Jan. 24

Total (1000 bbls.)
(Bureau of Mines Data)

12 Mos. '52	1,189,149
12 Mos. '51	1,130,584
Change	+58,565
% Change	5.2

*Dec. estimated from API data

BM Forecast of Motor Fuel Demand, 1953
(Dec. 26, 1952; 1000 b/d avg. by quarters)
1st Q., 3,055 2nd Q., 3,560 3d Q., 3,609 4th Q., 3,402

Gasoline Stocks

Finished and unfinished, end of month (1000 bbls.)

Jan. '53 API*	145,879
Dec. '52 API	135,905
Nov. '52 BM	129,509
Jan. '52 BM	144,339

*Jan. 24

Heating Oils Production

(Kerosine and Distillates)
Daily Average (1000 bbls.)

	Kerosine	Dist. Fuels	TOTAL
Jan. '53 API*	413	1,567	1,980
Jan. '52 BM	421	1,456	1,877
Change	−8	+111	+103
% Change	1.9	7.6	5.5

*Through Jan. 24

Total (1000 bbls.)
(Bureau of Mines Data)

12 Mos. '52*	132,383	521,616	653,999
12 Mos. '51	135,742	475,801	611,543
Change	−3,359	+45,815	+42,456
% Change	2.4	9.6	6.9

*Dec. estimated from API data

Heating Oils Demand

Daily Average (1000 bbls.)

	Kerosine	Dist. Fuels	TOTAL
Jan. '53 API*	563	2,261	2,824
Jan. '52 BM	508	2,081	2,639
Change	+5	+180	+185
% Change	1.0	8.6	7.0

*Through Jan. 24

Total (1000 bbls.)
(Bureau of Mines Data)

12 Mos. '52*	131,829	512,660	644,489
12 Mos. '51	130,532	471,751	602,283
Change	+1,297	+40,909	+42,206
% Change	1.0	8.6	7.0

*Dec. estimated from API data

BM Forecast of Heating Oils Demand, 1953
(Dec. 26, 1952; 1000 b/d avg. by quarters)
1st Q., 2,566 2nd Q., 1,352 3d Q., 1,250 4th Q., 2,272

Heating Oil Stocks

(1000 bbls. end of month)

	Kerosine	Dist. Fuels	TOTAL
Jan. '53 API*	23,890	85,179	109,069
Dec. '52 API	27,490	101,843	129,333
Nov. '52 BM	32,199	116,096	148,295
Jan. '52 BM	22,679	66,969	89,648

*Jan. 24

Fig. 6—Imports Swell Supply of Residual Fuels

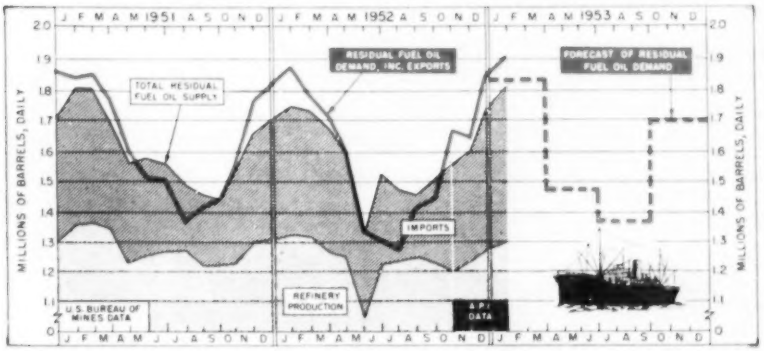
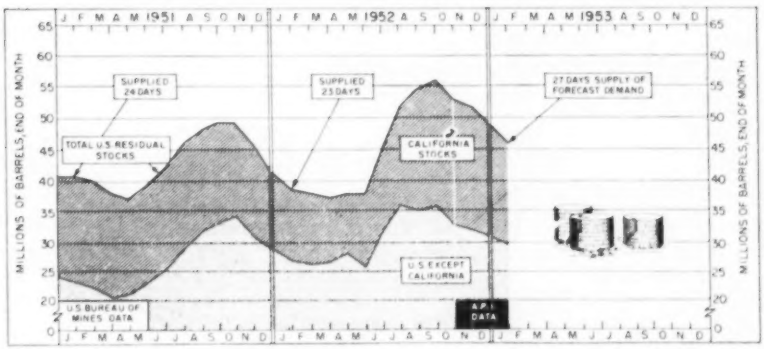

J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
MILLIONS OF BARRELS, DAILY
RESIDUAL FUEL OIL DEMAND, INC. EXPORTS
FORECAST OF RESIDUAL FUEL OIL DEMAND
TOTAL RESIDUAL FUEL OIL SUPPLY
IMPORTS
REFINERY PRODUCTION
U.S. BUREAU OF MINES DATA
A.P.I. DATA

Fig. 7—Continued Decline in Residual Stocks


J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
MILLIONS OF BARRELS, END OF MONTH
SUPPLIED 24 DAYS
SUPPLIED 23 DAYS
27 DAYS SUPPLY OF FORECAST DEMAND
TOTAL U.S. RESIDUAL STOCKS
CALIFORNIA STOCKS
U.S. EXCEPT CALIFORNIA
U.S. BUREAU OF MINES DATA
A.P.I. DATA

Residual Fuels Production

Daily Average (1000 bbls.)

	Refinery Output	Imports	TOTAL
Jan. '53 API*	1,301	518	1,819
Jan. '52 BM	1,338	418	1,756
Change	−37	+100	+63
% Change	2.7	23.9	3.5

*Through Jan. 24

Total (1000 bbls.)
(Bureau of Mines Data)

12 Mos. '52*	454,175	126,089	580,264
12 Mos. '51	469,377	118,675	588,052
Change	−15,202	+7,414	−7,788
% Change	3.2	6.2	1.3

*Dec. estimated from API data

Residual Fuels Demand

Daily Average (1000 bbls.)

Jan. '53 API*	1,911
Jan. '52 BM	1,887
Change	+24
% Change	1.3

*Through Jan. 24

Total Demand (1000 bbls.)

12 Mos. '52*	578,937
12 Mos. '51	592,745
Change	−13,808
% Change	2.3

*Dec. estimated from API data

BM Forecast Residual Fuels Demand, 1953
(Dec. 26, 1952; 1000 b/d avg. by quarters)
1st Q., 1,844 2nd Q., 1,494 3d Q., 1,370 4th Q., 1,707

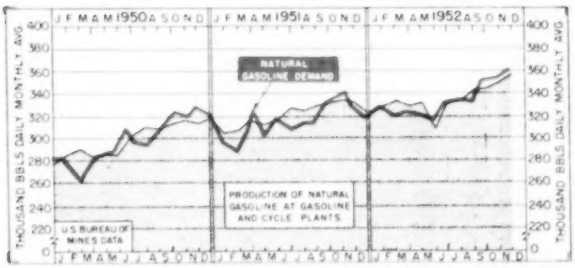
Residual Fuel Stocks

1000 bbls. end of month

	U.S. Except California	TOTAL U.S.
Jan. '53 API*	29,901	46,918
Dec. '52 API	31,226	49,117
Nov. '52 BM	33,469	53,069
Jan. '52 BM	27,911	39,523

*Jan. 24

Fig. 8—Supply and Demand of Natural Gas Liquids


J F M A M 1950 A S O N D
J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
THOUSAND BBLS DAILY MONTHLY AVG
NATURAL GASOLINE DEMAND
PRODUCTION OF NATURAL GASOLINE AT GASOLINE AND CYCLE PLANTS
U.S. BUREAU OF MINES DATA

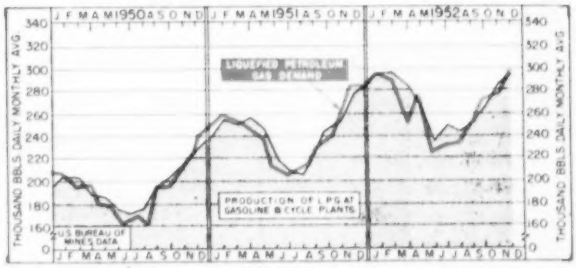
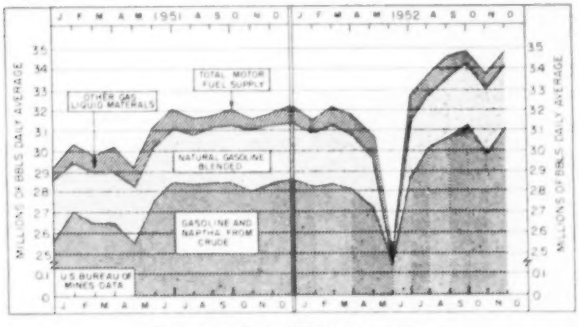

J F M A M 1950 A S O N D
J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
THOUSAND BBLS DAILY MONTHLY AVG
LIQUEFIED PETROLEUM GAS DEMAND
PRODUCTION OF LPG AT GASOLINE & CYCLE PLANTS
U.S. BUREAU OF MINES DATA

Fig. 9—Makeup of U. S. Motor Fuel Supply


J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
MILLIONS OF BBLS DAILY AVERAGE
TOTAL MOTOR FUEL SUPPLY
OTHER GAS LIQUID MATERIALS
NATURAL GASOLINE BLENDED
GASOLINE AND NAPTHA FROM CRUDE
U.S. BUREAU OF MINES DATA

(Figures in table in 1000 bbls./day average)

	Gasoline & Naphtha from Crude	Natural Blended	Other Gas Liquid Materials	Total Motor Fuel Supply
Nov. '52*	3,105	311	80	3,496
Oct. '52	2,986	315	82	3,383
Sept. '52	3,122	306	71	3,499
Nov. '51	2,853	297	65	3,125

Natural Gas Liquids Statistics

(Source: U. S. Bureau of Mines Report on Natural Gasoline and Cycle Plant Operations)

	Supply* (1000 bbls./day avg.) Natural Gasoline	LPG	TOTAL	Demand** (1000 bbls./day avg.) Natural Gasoline	LPG	TOTAL
Nov. '52*	356	295	651	360	300	660
Nov. '51	330	275	605	327	282	609
Change	+26	+20	+46	+33	+18	+51
% Change	7.9	7.3	7.6	10.1	6.4	8.4
	Total Supply (1000 bbls.)			Total Demand (1000 bbls.)		
11 Mos. '52*	112,175	90,353	202,526	112,531	88,881	201,412
11 Mos. '51	100,958	79,629	186,587	105,472	79,079	184,551
Change	+5,215	+10,724	+15,939	+7,059	+9,802	+16,861
% Change	4.9	13.5	8.6	6.7	12.4	9.1

Stocks, End of Month (1000 bbls.)

	By type of product (At gasoline plants and terminals only) LPG	Natural Gasoline	Condensate	Finished Gasoline†	By Location Gasoline Plants	Refineries	Total
Nov. '52	2,744	2,133	294	1,287	6,458	2,126	8,584
Oct. '52	2,892	2,099	263	1,185	6,739	2,151	8,890
Sept. '52	2,661	2,287	294	1,117	6,459	2,267	8,926
Aug. '52	2,805	2,858	261	1,162	7,086	2,636	9,722

*Supply includes receipts from refineries as well as current production from natural gasoline and cycling plants. Receipts from refineries in November included 168,000 bbls. of natural gasoline and 2,000 bbls. of naphtha.

**Demand does not include injected refinery gases produced for fuel and chemical purposes which totaled 2,656,000 bbls. in November.

†Includes naphtha and other products.

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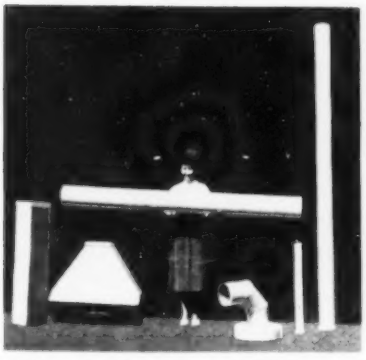


Solid Plastic Fume Ducts and Hoods Are Easy to Install

. . . because of light weight and simple method of field joints. Corrosion-proof, the complete line is offered in polyester glass combinations as well as "Rigivin," a rigid vinyl type, and "Rigidene," a polyethylene type. The glass-reinforced type, trade-named "Rigidon," has high acid resistance and will withstand operating temperatures in excess of 200° F. Units are standardized in both round and rectangular duct sections and hook designs, and are manufactured in accordance with recommendations for ventilating open process tanks by ASA. Heil Process Equipment Corp., 12901 Elmwood Ave., Cleveland 11, Ohio.

Circle No. **1** *on Reply Card*

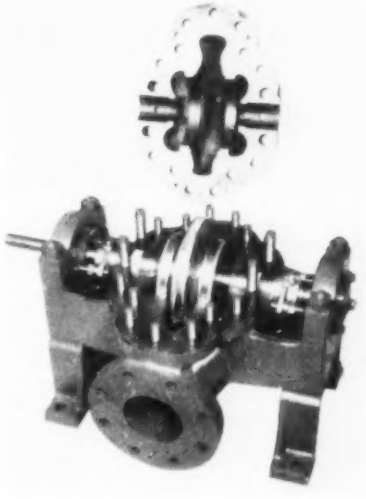
Ceramic Bubble Caps Designed With High Compression Strength

. . . will safely withstand normal thermal shock. They are inert to all acids, solvents, and corrosive solutions except hydrofluoric acid. Furnished with a high glaze finish if desired, the caps are made to specifications and use the same type of hold-down pins or bolts as steel caps. They are choke-resistant and self-cleaning. The manufacturing process includes pressing and forming the "green" stock into the desired shapes, firing them in kilns under very high temperatures; then grinding, lapping, or glazing the surfaces to the desired dimensions. Keystone Tool Corp., 5325 Kirby Dr., Houston, Texas.

Circle No. **2** *on Reply Card*

For More Information

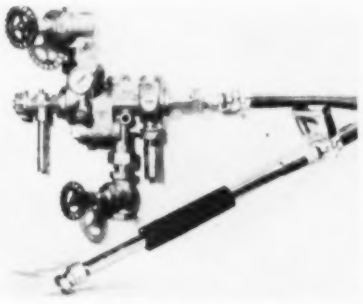
Use one of the attached reply cards to request additional details or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the rest of the card and drop it in the mail. No postage required.



New Centrifugal Pump Line Has Capacities, 200 to 6400 gpm

. . . and heads to 260 ft., in single stage, double suction design. With gland and seal assemblies meeting current strength requirements and specifications of the petroleum refiner, the Fig. 3405 pumps have unusual compactness. Bearing spans have been kept the shortest practical, resulting in overall length savings of as much as 50% on some models. Pump casings are horizontally split. Removal of the upper half permits complete inspection, maintenance and removal of the rotating element without disturbing piping or pump and driver alignment. Wide interchangeability of parts makes possible 19 different sizes in three groups. In addition, a locking design of shaft sleeve permits changing impeller rotation direction in the field without extra parts. Pumps can be supplied with electric motor, belt, or steam turbine drives. Impeller is cast in one piece of iron or bronze, depending on requirements. Bearing housings are completely sealed, making the pump suitable for outdoor installations. Water-cooled bearings can be supplied. Goulds Pumps, Inc., Dept. OP, Seneca Falls, N. Y.

Circle No. **3** *on Reply Card*



Booster Permits Jet Cleaning With 5 to 25 psi. Plant Steam

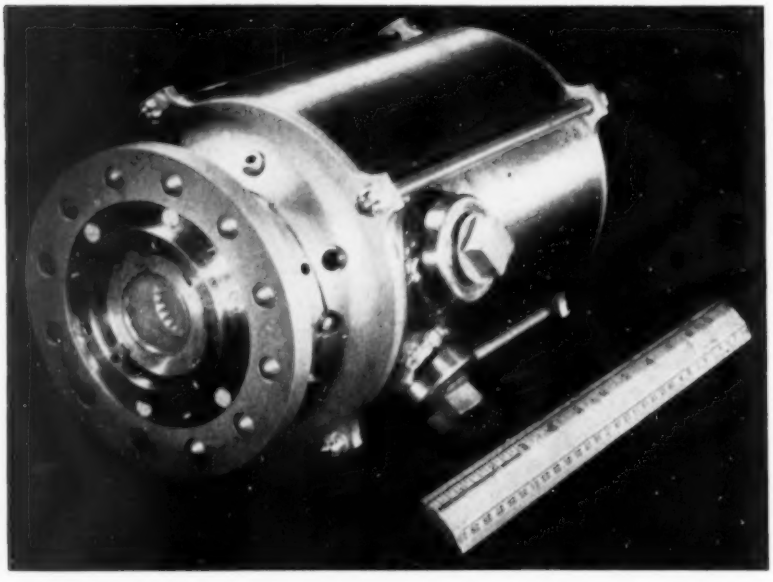
. . . and ordinary cold water plus detergents. The Sellers "Booster Jet" will convert 5 psi. inlet stream to 100 psi. discharge; 25 psi. inlet to 200 psi. discharge. Length of the 160 to 210° F. hydraulic stream of water (containing up to 25%-vol. of detergents) is manually controlled to extend as far as 30 ft. from the discharge nozzle. Among uses in refineries suggested for the booster by the manufacturer are: cleaning compressor pits, salt lines, exchanger bundles, bubble caps, cooling coils, pumps, steel tank plate before painting, floor and stair treads, etc. Sellers Injector Corp., 1603K Hamilton St., Philadelphia 30, Penna.

Circle No. **4** *on Reply Card*

Portable Fire Fighting Shield Uses Reflective Aluminum Foil

. . . backed up with a fire resistant protective cloth. Maker says firemen can move within inches of the fire when using the shield. A cut-out covered with a movable flap permits the fire fighter to insert the hose nozzle. A small hole near the top (at eye level height) is used to watch and direct the hose. Firemen can roll the shield up into a small diameter tube to carry easily. Once unrolled and set up, it will stand alone, or it can be made firm, by inserting two collapsible rods into the ground. Frommelt Industries, Dubuque, Iowa.

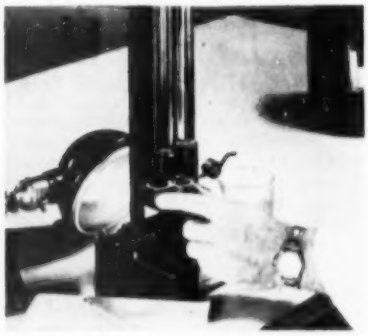
Circle No. **5** *on Reply Card*



Heat Rise-Flow Type Water Brake

. . . dynamometer, designed to absorb power loads as high as 1000 hp. Up to the present time, the "Hydra-Brake" has been widely used in jet engine studies, but it is expected to find use in industry. Extremely compact—the unit illustrated weighs 35 lbs. and is rated at 600 hp. at 8,000 rpm.—standard units in the complete line range in weight to 55 lbs. with overall dimensions within 14 x 10 in. The instruments are easy to move from one test location to another. Standard styles require no cradle or torque arm, and are mounted directly on the frame of the machine under test. Basis of the device's performance characteristics is in a novel, tortuously-ported stator and rotor disc construction. The spinning action of the rotors causes the water to form a layer around the inner periphery of the housing—by centrifugal action. A very high rate of shear is applied to this water layer by the whirling discs to provide drag action. The drag is augmented greatly by virtue of the acceleration and deceleration of the water as it passes through the ports of the rotating discs and the stators in its path from inlet to discharge. Use of conventional instrumentation to meter the water flow rate in lbs/min. and the temperature rise through the brake provides the necessary information for determining hp. within 2% tolerances. Industrial Engrg. Co., Island Rd. and Suffolk St., Philadelphia 42, Penna.

Circle No. **6** *on Reply Card*



Rotating Turret Chromometer Speeds up Color Determinations

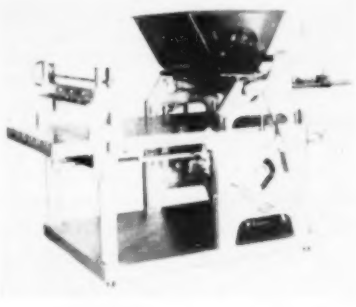
. . . on naphtha and kerosene. The new, improved Fisher/Tag Saybolt Chromometer has a turret head which revolves, eliminating the time-consuming, one-at-a-time changes of color discs necessary in older models. The operator simply rotates one disc-combination after another into place under the reference tube until he finds a color standard slightly lighter than the oil. The sample is then slowly drained out of the graduated tube through a petcock until sample and standard match. Then the height of the sample is read, and the Saybolt Chromometer Color Shade is found in a table hinged to the back of the instrument. Formerly, each color disc or combination of discs had to be removed and replaced by hand. Comparison tubes have the 17 mm. inside diameter, required under the new official ASTM specifications for the D-156 method. Complete instrument includes three-station revolving turret and Saybolt color discs; stand; tubes; eyepiece; diffusing mirror; integral etched-metal conversion table; wooden carrying case, and operating instructions. A daylight illuminator is available as an accessory. Older models of the Chromometer can be modified to use the new turret. Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Penna.

Circle No. **7** *on Reply Card*

Versatile Flame Cutter Helps in Salvaging All Types of Fittings

. . . welding ells, tees, flanges, etc. A precision jig with revolving table and accessories, the "Universal" Flame Cutter will cut ells to any angle, shorten ells, tees, flanges, reducers, etc., and will re-cut and bevel used ells, tees, swedges and returns. It can cut small miters—22½° or less; cut holes in blanks for slip-on reducing flanges; make swedges out of welding caps; and cut and bevel short pieces of pipe up to 36 in. in diameter. Mounted on a steel base, the table rotates in either direction at speeds varying from 0-5 rpm. Vernon Tool Co. Ltd., 1101 S. Meridian Ave., Alhambra, Calif.

Circle No. **8** *on Reply Card*



New Machine Fills and Caps Up to 120 Containers/minute

. . . of almost any liquid—lubricants, paints, chemicals, etc. It will fill from several ounces to quarts, and sizes up to gallons can also be handled by addition of a few parts. Containers can be fed automatically or manually. One operator is required to put the caps on: the machine presses them in place. All contact parts in the machine are bronze or stainless steel. Starting and stopping impulses are minimized because containers are indexed through the unit by a combination walking beam and pin lug type push rods. An automatic feeder and agitator can be provided if required. The Filler Machine Co., Philmont Club Station, Penna.

Circle No. **9** *on Reply Card*

Panel-mounting Potentiometers Have High Order of Accuracy

. . . with linearity to better than ±0.01%, and total resistance to better than ±0.05%. Rather than the single resistance element used in conventional potentiometers, the "Dekapot" Model DP-211 has two decades of fixed resistors and an interpolating slidewire to accomplish the voltage division. The dial arrangement gives an effective scale length of 390 in., approximately the equivalent of a 100-turn helical potentiometer. The digits of a given setting are read directly in a horizontal line on the flat face of the operating dial. The resistance wire used has a temperature coefficient of less than ±0.002% per °C. Units are now available in total resistances of 10,000 ohms. A variety of other values can be had on special order. Brown Electro-Measurement Corp., 4635 S. E. Hawthorne Blvd., Portland 15, Ore.

Circle No. **10** *on Reply Card*

Tiny Purge Flowmeters Permit Manual Control of Small Flows

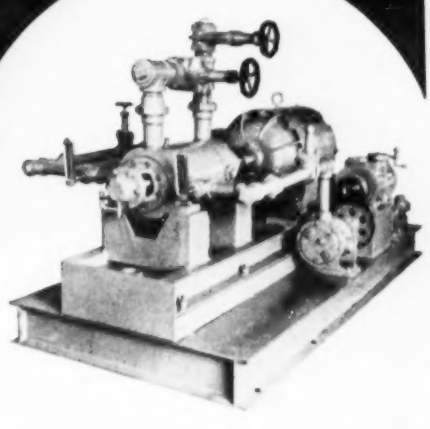
. . . at low cost with good reproducibility but moderate accuracy. Typical applications for the new S&K Purge Rotameter include the indication of: (1) flow of supply air in bubbler type liquid level measuring installations; (2) flow of purge fluid, generally water or air, in the lines connecting orifices, venturi tubes, or nozzles to differential head flow meters; (3) flow of transparent purge fluid to sight glass indicators of Rotameters measuring the flow of opaque fluids; (4) flow purge fluids to indicator extensions of indicating Rotameters or to extension wells of Rotameters with electric or pneumatic transmitters where the process fluid carries slurries; and (5) flow of

sample fluid to measuring installations for continuous chemical analysis of fluids. Small size, variable area meters for low ranges, the meters include a back flow check valve. A flow control valve for fluid passing through covers the entire range of the meter at differential pressures between 1 and 100 psi. The units must be installed vertically. Schutte and Koerting Co., Dept. M-C, Cornwells Heights, Bucks County, Penna.

Circle No. **11** *on Reply Card*

the *Turbinizer*

for continuous production of complete dispersions or emulsions



It's unique — operates on principle of hydraulic shear — requires no close operating clearances — has no contacting surfaces to wear out.

It's fast — produces thorough dispersions at up to 5000 gals./hr.

It's versatile — handles anything pumpable — liquids, powdered solids or gases — including component materials of widely different viscosities.

It's flexible — can be used for blending, dissolving, dispersing, emulsifying extracting, reacting, scrubbing and homogenizing.

It's adaptable — can be easily piped for controlled recirculation or predischarge dilution.

It's compact — unit and auxiliary equipment mounts on single base.

It's precise — can be jacketed for close temperature control and otherwise fully instrumentated.

It's simple — no close adjustments need be made or maintained — no special operator training required.

It's quiet — despite high speed it's almost vibrationless in operation.

It's easily cleaned — quickly drains free — "hold-up" ranges from 1 quart to 1 gallon — wastage is extremely low.

It's economical — the lack of close clearance, the abrasion resistance of moving parts, the rugged construction minimize wear and repair.

Write for details, today

ASK FOR BULLETIN T-52

4506

THE U. S. STONEWARE CO.

PROCESS EQUIPMENT DIVISION

AKRON 9, OHIO

Now!

STEAM AND MECHANICAL ATOMIZATION COMBINED . . . NATIONAL AIROIL DUAL STAGE OIL BURNER

Now, at last, the inherent advantages of both systems of fuel oil atomization are profitably yours . . . within the one, new NATIONAL AIROIL Dual Stage Burner.

41 years of combustion equipment design and manufacture are in back of the Dual Stage Oil Burner . . . and, it has been thoroughly tested and proved in the field for firing: Petroleum Processing Heaters; Rotary Kilns; H.R.T., Scotch Marine and Water Tube Boilers; etc.

Available in three sizes, the NATIONAL AIROIL Dual Stage Burner fires all grades of fuel oil from No. 2 to No. 6, with a ready capacity of 80 to 300 g.p.h. Further, for a perfect flame pattern, we would recommend using with the Dual Stage Burner either the NATIONAL AIROIL Universal Register for forced draft or, the NATIONAL AIROIL Tandem Unit for natural or induced draft furnaces.

Get detailed description, illustration, and specifications in NATIONAL AIROIL Bulletin 25.

CHEMICAL PETROLEUM DIVISION

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Industrial Oil Burners, Gas Burners, Furnace Equipment

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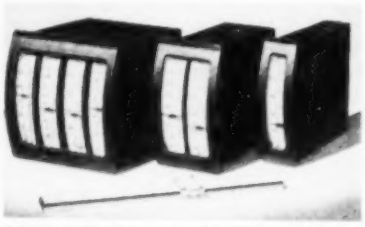


New Miniature, Vertical Scale Instruments Intergengeable

. . . either as complete assemblies or by separate parts. Designed for panel mounting, the Dickson "Mindicators" are used on graphic or standard control boards as receivers and as direct reading gages and thermometers. All units have a legible 4-in. scale, yet require a panel opening of only 5⅜ x 1½ in. for single units and 1⅜ in. additional width for each unit added to a multiple housing. Those designed as receivers operate on transmitted pressure of 3 to 15 psig., using individually calibrated metallic bellows measuring elements. Thermometers are available in any required range from as low as −200° F. to as high as 1,000° F. They have flexible stainless braid armored capillary connecting tubes for lengths to 150 ft. Pressure gages have scale ranges from 0-10 psig. to 0-1,000 psig. Metallic bellows are used on ranges below 60 psig.; Dickson spiral bourdon tubes on the higher ranges. The Dickson Co., 7420 Woodlawn Ave., Chicago 19, Ill.

Circle No. **12** *on Reply Card*

DID YOU MISS THESE?

The following items, reviewed originally in the December, 1952, issue, have aroused considerable interest. They are repeated briefly as a service to those who might have missed them the first time. For details or literature, use the regular Reply Card in this issue.

New Pressure-measuring Unit Has Accuracy of 1 in 5000

Using 50 ft. of 35-mm. film as a scale with intervals of 1/16 in. representing 1/10,000 of the full pressure range, the new "Press-I-Cell" has an accuracy of one part in 5000 and a sensitivity of 1 in 15,000. The device is not intended by the manufacturer to replace standard instruments used where extreme accuracy is not required. Suggested applications, rather, include: a master laboratory calibration instrument; liquid level gage for large tanks; field tests requiring high precision or sensitivity in a compact test gage. Typical ranges are 1 atm absolute, 400-in. water column, and 150-in. Hg. differential. Two models are available: manual, and automatic (scale positioned by a servomotor). In the latter type, correct reading is obtained with no hunting or oscillation. Repeatability is rated at 1 in 700. Fischer & Porter Co., Hatboro, Penna.

Circle No. **13** *on Reply Card*

Electronic Color Alarm Stops Need of Rerunning Kerosene

The Hallikainen-Shell Development Color Alarm is a differential type colorimeter giving an alarm or visual signal when the preset color has been exceeded. It's already been used for controlling kerosene color and preventing rerunning. A low-powered electric lamp provides a light source, part of which traverses the sample cell and is reflected to pass again through the cell and fall on a small phototube. A second tube as a reference receives light from the same source. Quantity of light reaching the reference tube is adjusted by a regulatable shield with a wedge-shaped opening. Liquid of a darker color flowing through the sample cell unbalances the circuit, energizing or de-energizing the signal light. Instrument is stable to about 1/10 of a Union color number on kerosene under usual line voltage fluctuations. Available in explosion-proof and standard models, also for continuous indication. Hallikainen Instruments, 1341 Seventh St., Berkeley, Calif.

Circle No. **14** *on Reply Card*

Ethylbenzene Information

Ethylbenzene, Technical Data Report TX-12; twelve pages of chemical, physical, and reaction data on this aromatic hydrocarbon, a water white liquid boiling at 136° C.; typical reactions including oxidation, nitration, sulfonation, hydrogenation, dehydrogenation, halogenation, alkylation, and acylation. Monsanto Chemical Co., Texas Div., Texas City, Texas.

Circle No. **15** *on Reply Card*

Lubricants—1902-1952

Lubrication, December, 1952; devotes all 16 pages to a brief historical review of developments in the field of lubricants for the past 50 years. The Texas Co., 135 East 42nd St., New York 17, N. Y.

Circle No. **16** *on Reply Card*

Assures Positive Distance Reading of Liquid Levels

JERGUSON TRUSCALE GAGE

THE modern design JERGUSON TRUSCALE GAGE gives new accuracy for reading of liquid levels in boilers, deaerating tanks, etc.

Here is the remote reading gage which incorporates all of the newest engineering features! The Jerguson Truscale has exceptional sensitivity, with ability to register changes as small as ½ of 1% of range! The translucent dial scale is clearly lighted from behind, and is easy to read.

Available with positive alarm system. Lights and horn signal too high or too low water level.

Visible Alarm

Horn

Available with Repeaters which repeat accurate level readings at auxiliary locations.

Marine Operators: *Special installation procedure compensates for roll and pitch of your ship.*

Repeater

Write for Truscale Catalog

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

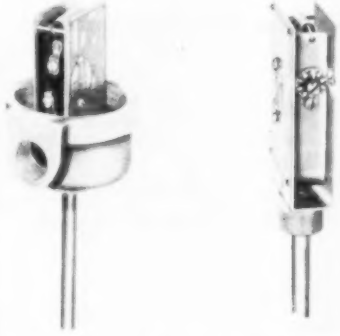
JERGUSON GAGE & VALVE COMPANY
100 Fellsway, Somerville 45, Mass.
Representatives in Major Cities
Phone Listed Under JERGUSON
In Europe: Bailey Meters & Controls, Ltd.

What's New

Telephone Hose Mask Combined For Safety in Cleaning Tanks

. . . by providing two-way communication between workers inside and outside. Tried out in underground fuel storage tanks at Tinker Air Force Base, Oklahoma City, the "Maskfone" enables the man inside to report if he needs more air; if the air hose becomes fouled on an obstruction; or to advise of any unusual hazard. The idea was borrowed from deep-sea diving practice. No outside power source is needed for voice transmission, even over miles of connecting cable. In effect, the voice vibration provides the needed power. Connecting cable is neoprene covered. Maskfones can also be used in types other than hose masks, for example, canister type, tank-type, or oxygen generating units. Mine Safety Appliances Co., Pittsburgh, Penna.

Circle No. **17** *on Reply Card*



Small Temperature Control Has Range from —300 to +300 F.

. . . operating on the principle of differential expansion of solids. Designed for use in the laboratory, the temperature sensing element consists of a high expanding outer tube and low expanding inner member. The

GLIDDOL by Glidden

THE PROVED SOYBEAN ADDITIVE

From the first shipment, Gliddol has been produced under rigid laboratory control to prescription standards. Here is the proved soybean additive—best for lube oil, fuel oil, grease and gasoline.

QUALITY Glidden PRODUCTS

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1825 N. Laramie Avenue • Chicago 39, Illinois

WANT IT LATER?

You can delay that signal with an

ERA BOUNDARY DISPLACEMENT MAGNETIC RECORDING DELAY LINE

FREQUENCY RANGE—any five octave band between 5 cps and 30,000 cps, with appropriate drum speed. DELAY—up to 1000 wavelengths of information storage per channel; 200-second delay maximum at 5 cps—proportionately less with increase in frequency. NUMBER OF CHANNELS—1 to 16. MAGNETIC DRUM NON-CONTACT RECORDING—eliminates wear of recording medium; permanent drum recording surface may be used indefinitely. BOUNDARY DISPLACEMENT TECHNIQUE—provides a high degree of amplitude linearity; minimizes modulation effects due to non-homogeneity of recording medium or slight variations in head-to-drum spacing. SEND YOUR DELAY LINE REQUIREMENTS to:

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Division of **Remington Rand**
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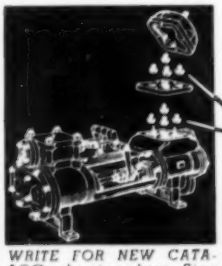
DIGITAL COMPUTERS • DATA-HANDLING SYSTEMS • MAGNETIC STORAGE SYSTEMS • INSTRUMENTS • ANALOG MAGNETIC RECORDING SYSTEMS • COMMUNICATIONS EQUIPMENT

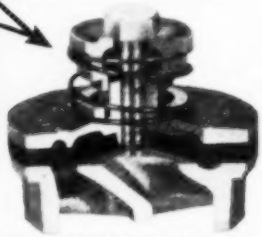
BETTER PUMP PERFORMANCE MEANS *Less Maintenance*

SIMS PUMP

Sims Pump Valves are guaranteed to give you better pump performance. And that means time, money and tempers saved.



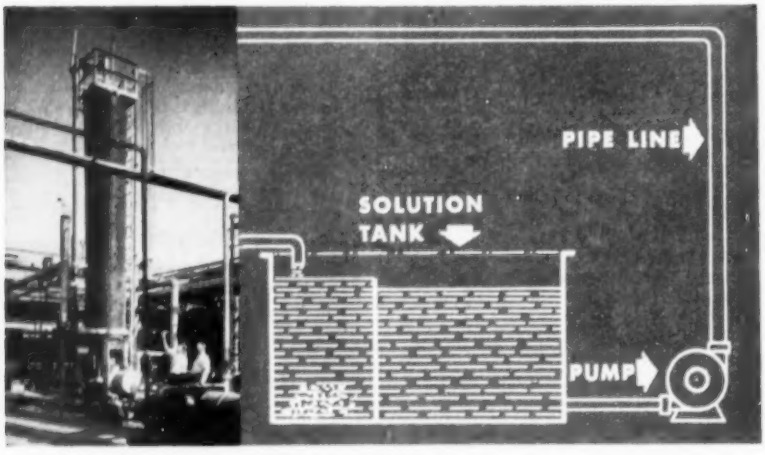
1. Discs rotate for minimum wear while cushioned by liquid top and bottom. 2. Inclined ribbed seat and cushioned stem head combine to give smoother, faster valve action and take up shock.



WRITE FOR NEW CATALOG showing how Sims Valves fit your pump for better performance.

VALVE CO., INC.

145 HUDSON ST., NEW YORK 13, N. Y. • M & M BLDG., HOUSTON, TEXAS



Tower cleaning cost cut by $1000

Here's the blueprint of a chemical cleaning installation that saves one refiner $1000 on his tower maintenance.

Material? Recommended Oakite detergent solution for speedy, thorough removal of grease, waxes, entrained crude—iron sulfides, chlorides, oxides.

Method? *In-place* circulation of solution. No dismantling, reaming or sawing. Cuts *days* off cleaning time.

Results? Men who use it say: "Never spent 80 bucks so happily to save $1000." "Increased output 400 gallons per hour." "Good results—even trays near top come out clean."

Details? Absolutely *free*, including blueprints. Write Oakite Products, Inc., 37 Rector St., New York 6, N. Y.

Technical Service Representatives in Principal Cities of U. S. & Canada

SPECIALIZED INDUSTRIAL CLEANING

OAKITE

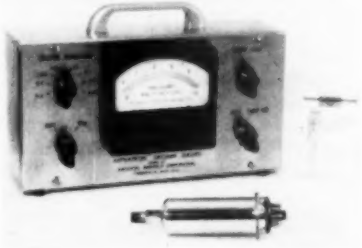
MATERIALS • METHODS • SERVICE

PETROLEUM SERVICE DIVISION

What's New!

relative motions caused by temperature changes are multiplied by a lever which actuates a micro switch. A dial graduated 1 to 10, together with an adjusting screw with pointer and locking set screw, provides regulation of the temperature settings. Instrument is enclosed in a waterproof aluminum cast housing with gasketed joints. A ½-in. IPS hole in the housing is provided for wiring. Standard tube lengths are 5, 10, and 15 in.; with the 10-in. recommended for most applications. Standard tube diameters are ⅜ and ½ in. O.D. Fittings for mounting the instruments are available with the ⅜-in. O.D. tubes. The switch has snap-acting contacts rated by Underwriters Laboratories for 15 amps., 125-250-460 volts, 60 cycles, A.C. Any one of three switch actions may be specified: normally closed (opens on temperature rise); normally open (closes on temperature rise); or single pole double throw. Burling Instrument Co., 5 Vose Ave., South Orange, N. J.

Circle No. **18** *on Reply Card*



Vacuum Gage Meters Pressure Down to 0.0001 mm. Absolute

. . . with accuracy of ±2% of full scale. The principle of operation is related to the conventional hot filament ionization gage, but the new Type 511 "Alphatron" uses a shielded radioactive source instead of the filament. Alpha particles ionize the gas. Ionization current produced is measured by a DC amplifier calibrated to give absolute pressure in mm. of Hg. Sensing element and first stage amplifier are housed in a steel envelope weighing only four ounces. Attachment to the vacuum system is by a ⅛-in. standard pipe thread tube. Power supply (batteries) and balance of device is incorporated in a stainless steel housing weighing seven lbs. Linear indications of total pressure are provided between 1000 mm. and 0.0001 mm. by ranges of 0 to 1000, 100, 10, 1, 0.1, and 0.01 mm. Response speed to pressure changes is instantaneous, making gage useful also as a leak detector. Any heavy contamination can be flushed out with a suitable solvent. National Research Corp., 70 Memorial Dr., Cambridge, Mass.

Circle No. **19** *on Reply Card*

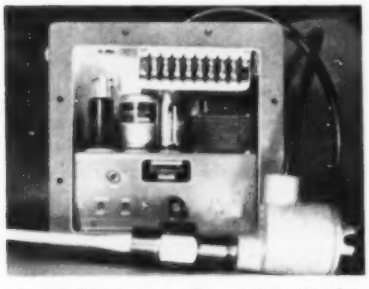
(To obtain more data on advertised products see page 280)

What's New!

Load Scale on Pipe Support Will Permit Quick Field Adjustment

. . . of at least ±10% by turning a single adjusting bolt. The new Model R hanger is said to give constant support that is mathematically perfect for all positions of travel for high temperature process and steam piping. Hangers can be bolted directly to the supporting structure and frames are drilled for either single or double rod suspension. Three regular frame sizes providing maximum travels of 4, 8, and 12 in. will take care of loads from 48 to 9,304 lbs. Hangers are non-resonant. Anti-friction needle bearings reduce friction to a minimum. Each hanger is calibrated individually before shipment to support the exact load specified. Grinnell Co., Inc., 260 West Exchange St., Providence 1, R. I.

Circle No. 20 on Reply Card



Level Detector Operates Under Severe Temperature, Corrosion

. . . because the sensing element can be protected. The element, a capacitance probe, may be used bare or covered with various insulating materials such as nylon, teflon, neoprene, polyethylene, rubber and ceramic, depending upon the corrosive conditions. The indicator and amplifier unit, which may be remotely mounted—up to 100 ft. from the

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ASPHALT SPECIALTIES

WEATHERCOAT
Slows Weathering

WEATHER and WATER can't affect the protective qualities of Weathercoat: this tough ductile asphaltic coating *bridges* expansion, but remains firm under heat or cold.

That's why Weathercoat is preferred by most of the world's largest refineries* for protection of exposed insulation on fractionating columns, crude stills and tanks . . . for sealing insulation joints . . . exposed insulated pipelines . . . for membranes in reservoirs.

No fire hazard—apply it cold!
Brush, trowel or spray Weathercoat —it's easy—"palms" beautifully over uneven surfaces!

*Names on Request

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COMPANY

200 BUSH ST. • SAN FRANCISCO 4, CALIFORNIA

E. Providence 14, R. I. Perth Amboy, N. J. Baltimore 3, Md. Mobile, Ala. Columbus 15, Ohio
Tucson, Ariz. Seattle, Wash. Baton Rouge 2, La. St. Louis 17, Mo. Inglewood, Calif.
Oakland 1, Calif. Portland 7, Ore. Washington 6, D. C. San Juan 23, P. R.

(To obtain more data on advertised products see page 280)

You simply can't beat this new RIDGID Spiral for smooth easy reaming

★ This new improved Spiral reams burr from pipe as fast and cleanly as if it were wax . . . and makes quick work of enlarging conduit box outlets or cutting holes in sheet metal—and does it without chatter.

★ Improved ratchet handle—cutting edges of heat-treated tool steel for long service. You can't beat it for performance. Buy at your Supply House.

Remember also RIDGID LonGrip Reamer with extra-long taper.

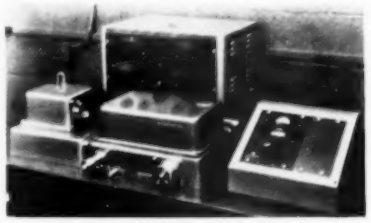
THE RIDGE TOOL COMPANY • ELYRIA, OHIO

RIDGID
Work-Saver Pipe Tools

What's New!

probe—is encased in an explosion-proof housing. The instrument has a tube complement of three, along with sensitivity adjustment and one double-pole double-throw, 110 v., 10 amp., contact relay. Each contact is available on a terminal strip for ease in making connections. Temperatures may range from —65 to +1500° F., with a working pressure of 30 in. vac. to 1000 psi. on the probe itself, and from —40 to +200° F. on the indicating unit. Instruments, Inc., 122 N. Madison, Tulsa, Okla.

Circle No. **21** *on Reply Card*



Infrared Spectrometer Handles Single-point Chemical Analyses

. . . at an accuracy of ±0.25%. The Model 112-S is designed principally for routine measurements of the concentration of one or more components in a mixture, checking for an impurity, routine raw material tests. Any wavelength within the range of the prism is quickly selected by a manually operated selector. Scattered radiation is reduced to less than 0.1% by double pass optics. The instrument is available in three wavelength ranges: near infrared (0.5 - 2.5 microns); fundamental region (2 - 15 microns); and far infrared (15 - 38 microns). It is easily converted from one spectral region to another. It may also be converted to an automatic recording instrument with the proper accessories. Perkin - Elmer Corp., Norwalk, Conn.

Circle No. **22** *on Reply Card*

New Additive Prevents Filter Clogging in Fuel Oil Burners

. . . and is now available in commercial quantities. Trade-named Santolene H, it inhibits the formation of fuel oil sludge and sediment, prevents deposition of such sludge which may already be present, and reduces rusting. Diesel engine tests have indicated identical benefits result, without harmful effects on engine operation. The material, a non-metallic base compound, does not contribute to the formation or stabilization of fuel oil-water emulsions and the attendant oil haze. It has substantially no effect on the carbon residue, nor is it subject to depletion by water extraction or reaction with

(To obtain more data on advertised products see page 280)

water. Manufacturer states it is effective with most base fuels at the rate of 3 gal. to 42,000 gals. of oil — a concentration of less than 0.01%. A dosage of 6 gals. to the same amount of fuel oil can be of advantage on initial batches to old distributing equipment. For rust protection of handling and storage equipment, dosage of 1.5 is adequate. Monsanto Chemical Co., St. Louis 4, Mo.

Circle No. **23** *on Reply Card*

Trade Literature

Induction Period Calculator

. . . designed to eliminate human errors in interpretation in the ASTM test for oxidation stability of gasoline, a circular type slide rule device, described in Data Sheet No. 11096. (See PETROLEUM PROCESSING, Sept., 1948, pp. 848-850, "Use Induction Period Calculator for Oxidation Stability Tests," by E. L. Korb, du Pont.) Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.

Circle No. **24** *on Reply Card*

Construction 75% Completed

. . . how it looks in an imaginary 100,000 b/d refinery and integrated petrochemical plant; large, detailed drawing in color shows the many activities involved in bringing a blueprint to reality; featured as a special center section in *Kelloggram*, Issue 2, 1952: balance of which describes company's construction dept. M. W. Kellogg Co., 225 Broadway, New York 7, N. Y.

Circle No. **25** *on Reply Card*

Electric Control Centers

. . . and their applications, with building-block system for planning and arrangement; including reference tables and data. Booklet B-5621. Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Penna.

Circle No. **26** *on Reply Card*

Oil Testing Equipment

. . . covered in comprehensive Fisher/Tag *Catalog* 53; including a new TEL-meter in addition to the standard apparatus. 40 pages, cross-indexed. Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Penna.

Circle No. **27** *on Reply Card*

Flow in Plastic Pipe

. . . plastic-lined pipe, and light wall steel pipe differs from that in standard pipe. *Table of Hydraulic Conversion Factors* provides data on friction, velocity and friction head for rubber and Saran lined Sched. 40 pipe, Uscolite, Saran and Parian, hard rubber, and Sched. 10 steel pipe, in sizes from ½ to 6 in. The Permutit Co., 330 West 42nd St., New York 36, N. Y.

Circle No. **28** *on Reply Card*

J-M BLAZECRETE speeds refractory repairs...

That's why it pays you to use this hydraulic setting refractory for temperatures to 3000F

REPAIR old refractory linings—or build new ones—quickly and economically with Blazecrete*. Just mix Blazecrete with water as you'd mix ordinary concrete . . . then gun it or slap-trowel it in place.

Either way, Blazecrete goes on fast . . . without laborious ramming or tamping. Even when gunned, it adheres readily with a minimum of rebound loss. *And Blazecrete linings last.*

Three types of hydraulic-setting Blazecrete are available. All harden on air curing, do not require prefiring. They are furnished as a dry mix . . . can be stored safely for use as needed.

3X BLAZECRETE—For temperatures through 3000F. Unusually effective for heavy patching, especially where brickwork is spalled or deeply eroded. Excellent for forge furnace linings, lime kilns, burner blocks, soaking pits, and industrial boilers.

STANDARD BLAZECRETE—For temperatures through 2400F. Makes repair work easier and less costly. Can be used by boiler manufacturers to replace fire clay tile in wall construction. Suitable for use in combination with 3X Blazecrete and L. W. Blazecrete.

L. W. BLAZECRETE—For temperatures through 2000F. An insulating refractory . . . light in weight, low in thermal conductivity. Adaptable and economical for many other applications.

Send for Brochure RC-28A on Blazecrete and its companion material, Firecrete*. . . the hydraulic setting castable refractory for making special shapes and linings. Write Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ontario.

*Reg. U.S. Pat. Off.

Whether you gun it...

or slap-trowel it...

Johns-Manville **BLAZECRETE**

BUILDS BETTER REFRACTORY LININGS

(To obtain more data on advertised products see page 280)

must be readily adaptable

FIELD MOUNTED
THE FLEXIBILITY OF THE CONTROLLER TYPIFIES
P-4 PNEUMATROL

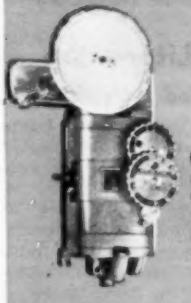
The "building block" design and construction of Fischer & Porter P-4 Pneumatrol units provides the maximum in versatility of use. These design features permit ready change of a case mounted Pneumatrol into a field mounted controller by the mere addition of pre-built, basic elements. This unique feature of the P-4 assures minimum spare parts inventory and simplifies servicing.

The P-485 field mounted controller combines the best features of force and motion balance controllers by the unique application of paired bellows elements for precision, speed and permanence. It is the fastest field mounted controller and yet has completely stable high frequency response. P-4 Pneumatrol units are extremely compact in size, simple in operation and completely corrosion resistant.

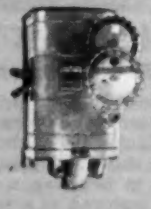
The plug-in type companion manifold has been just as thoroughly designed as the P-4 and includes built-in cut-off relay, automatic output cut-off below 1 psi setting pressure, positive self-sealing ports with unusually large air passages to prevent degrading the control response.

F&P P-4 Pneumatrol flow controllers are extremely versatile in their application. Complete information is yours for the asking. Write today!

P-485 FIELD MOUNTED CONTROLLER
(Proportional, Reset, Derivative) with plug-in air connections. Mounting plate includes shutoff relay and air check valves.



P-475 FLOW RATIO CONTROLLER
for wide range flow ratio requirements. Optional construction provides VARIABLE PNEUMATIC SET CONTROL.



P-45 CASE MOUNTED CONTROLLER
Proportional, Automatic Reset. Derivative Action obtained by installing snap-in resistor assembly below proportional dial.

P-43M CASE MOUNTED CONTROLLER
Wide band proportional with manual reset.

P-42 CASE MOUNTED CONTROLLER
Narrow band proportional.

P-41 CASE MOUNTED CONTROLLER
On-off action.

Temperature compensated precise pneumatic transmitter—a special form of the P-4 Pneumatrol utilizing many features.

FISCHER & PORTER CO.
2055 **1120 County Line Road, Hatboro, Penna.**

What's New!

Synthetic Methanol Data

. . . including specifications, uses, first aid data, properties, toxicology, test methods, shipping, handling, and storage. Thirty pages. Commercial Solvents Corp., Industrial Chemicals Dept., 260 Madison Ave., New York 16, N. Y.

Circle No. **29** *on Reply Card*

Centrifugal Blowers

. . . in 9 to 30-in. sizes for a utility type; also pressure type in size to 48-in., and up to 48,900 cfm. volume moving rates; covered in Catalog B-10. The line is a new product, just announced by Hartzell Propeller Fan Co., Piqua, Ohio.

Circle No. **30** *on Reply Card*

Insulation Specs for Refineries

. . . and chemical process plants is the subject of a 52-page brochure; a detailed reference with specifications for insulation for service above and below 100° F., for tanks, and for oil heaters; including thickness recommendations in seven tables. Johns-Manville, 22 East 40th St., New York 16, N. Y.

Circle No. **31** *on Reply Card*

Continuous Mass Spectrometry

. . . as a step toward automatic refineries, practiced at Esso; also how mass spectrometer controls a complex petrochemical process at Jefferson Chemical Co.; two articles in *CEC Recordings*, Dec., 1952. Consolidated Engrg. Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

Circle No. **32** *on Reply Card*

Flow Tube Theory

. . . and application explained in a technical booklet by Vincent Gentile, Jr., giving hydraulic formulas, head capacity curves and test data, as well as a table comparing performance of the flow tube and the venturi. Foster Engrg. Co., Union, N. J.

Circle No. **33** *on Reply Card*

Engineering Power Plants

. . . for the process industries, an article by A. D. Rust, Dow Chemical Co.; also another article on four new process units at Trinidad Leaseholds, Ltd.; in *Heat Engineering* for Dec., 1952. Foster Wheeler Corp., 165 Broadway, New York 6, N. Y.

Circle No. **34** *on Reply Card*

Petroleum Processing Index

. . . for the year 1952. It includes subject and author indexes for all feature articles and regular departments for the 12 issues of this magazine published during the past year. Platt's Petroleum Publications, 1213 West Third St., Cleveland 13, Ohio.

Circle No. **35** *on Reply Card*

Depend on AUTO-LITE for TEMPERATURE INDICATION

Model "V" is one of many Auto-Lite dial thermometers made for industry. The outline drawings show how this temperature indicator can be adapted to meet specific needs through various standard mountings. Send for our new Catalog No. G-143-B of Auto-Lite dial indicating and recording thermometers.

THE ELECTRIC AUTO-LITE COMPANY
INSTRUMENT AND GAUGE DIVISION (Dept. D)
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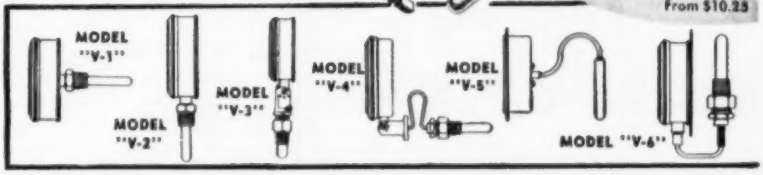
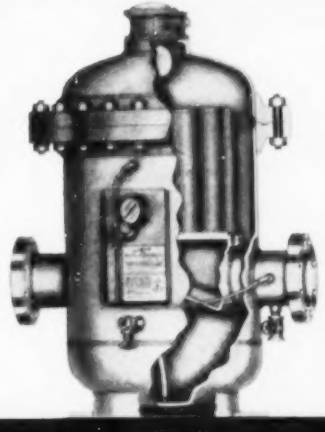
MODEL "V"
Vapor pressure type, with choice of standard dial ranges between minus 40°F. to plus 450°F.
From $10.25



EXCEL-SO
5 MICRON FILTERS
for finished PETROLEUM PRODUCTS



Designed to remove dirt (down to 5 microns) from finished petroleum products . . . removal of this microscopic rouge lengthens the life of jet and gasoline aircraft engines, pumps, meters, valves, and fittings. They are compact in size and are built for operating pressures from 0-2500 psi. EXCEL-SO Filters can be built to any code requirement, API-ASME, ASME or state codes for unfired pressure vessels. They also meet requirements of JAN or MIL specifications. Available in capacities from 10-2000 G.P.M. Special "Throwaway" Plastic Filter Bundle available on request. Write for Bulletin FO-52.

WARNER LEWIS COMPANY
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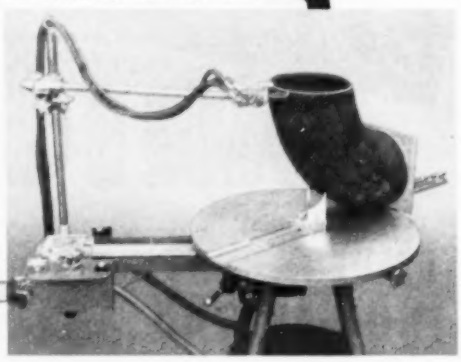
WELDING FITTINGS
VERNON



"Universal" FLAME CUTTER

Use this new precision "Universal" Flame Cutter for re-working, reconditioning and salvaging all types of new and used welding ells, tees, flanges, reducers, etc. Makes extremely clean cuts . . no cleaning or hand fitting required. Adjustable degree plate permits fitting to be cut at any angle. Has unitized control panel and unitized gas control valve.

Re-cutting a 6" 45° elbow, showing use of the adjustable degree plate.

Write for Bulletin FC-2

WHAT IT DOES

- Shortens ells, tees, flanges, reducers, etc.
- Miters welding neck flanges.
- Re-cuts and bevels used ells, tees, swedges, returns.
- Reconditions welding neck and slip-on flanges.
- Reams extra heavy fittings to standard.
- Cuts small miters . . . 22½° or less.
- Cuts holes in blanks for slip-on reducing flanges.
- Cuts and bevels short pieces of pipe to 36" diameter.
- Makes swedges out of welding caps.
- Cuts miter elbows.

VERNON TOOL CO., LTD.

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P.O. Box 7555 Houston 7, Texas

Vernon PIPE CUTTING PANTOGRAPH
Vernon "Universal" FLAME CUTTER
Brown STEEL VALVES
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A Book You Should Have on Mechanical Sealing...

A complete reference catalog on Dura Seal—the engineered mechanical seal that rotates with the shaft. Amply illustrated . . . specific applications . . . installation data. A fact book of real value to designers, operators and maintenance departments.

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DURAMETALLIC CORPORATION

DEPT. PP • KALAMAZOO, MICHIGAN

What's New!

Caustic Soda Information

. . . useful to the chemist, process engineer, purchasing agent; data on grades, manufacturing processes, analytical methods, shipping, handling precautions, containers, materials of construction for storage tanks, etc. 56-page booklet. Wyandotte Chemicals Corp. Michigan Alkali Div., Wyandotte, Mich.

Circle No. **36** *on Reply Card*

Entrainment Separators

. . . and mist eliminators and how they can improve the performance of process equipment such as vacuum towers. Catalog No. 13 on *Yorkmesh Demisters*. Otto H. York Co., Inc., East Orange, N. J.

Circle No. **37** *on Reply Card*

Reciprocating Pump Manual

. . . with instructions on installing and maintaining, plus general engineering information and data, contained in new 20-page service book, Bulletin 202. Warren Steam Pump Co., Inc., Waren, Mass.

Circle No. **38** *on Reply Card*

Fatty Acids and Derivatives

. . . are described in a booklet on "Hyfac" products—12-hydroxystearic acid and hydrogenated castor oil; giving properties and applications and a bibliography of patents and technical literature. Emery Industries, Inc., Dept. 5, Carew Tower, Cincinnati 2, Ohio.

Circle No. **39** *on Reply Card*

Rust Preventive Coatings

. . . with 73 color chips, instructions for surface preparation and application of complete line, with "in-use" illustrations. Form No. 252, a new 1953 general catalog. The Rust-Oleum Corp., 2799 Oakton St., Evanston, Ill.

Circle No. **40** *on Reply Card*

Crystal Lattice Structure

. . . easily and quickly demonstrated in new plastic model kit which builds in three dimensions—cubic, tetragonal, hexagonal, rhombic, monoclinic, triclinic, and other variations. *Bulletin D-3040*. Harshaw Chemical Co., 1945 East 97th St., Cleveland 6, Ohio.

Circle No. **41** *on Reply Card*

Direct Writing Recorders

. . . and their application to a wide variety of variable phenomena such as pressure, temperature, flow, gas analysis, displacement, voltage and current, etc., from electric transducers, where characteristics range from static to 100 cycles/sec. Bulletin, *Applicability of Sanborn Direct Writing Recording Systems*, includes performance data and specifications. Sanborn Co., 38a Osborn St., Cambridge, Mass.

Circle No. **42** *on Reply Card*

Sohio customers get full value every time

—in Tri-Sure equipped drums

Drums of Sohio petroleum products are delivered to thousands of farms, factories and service stations in Ohio. And *full value* is delivered in every drum because it is protected from leakage, tampering and losses by Tri-Sure* Closures.

For over 15 years, The Standard Oil Company (Ohio) has used Tri-Sure Closures to assure the *safe* delivery of sealed-in quality. And during all those years the Tri-Sure Flange, Plug and Seal have given unfailing security—proof that Tri-Sure protection is always *dependable* protection.

Give this protection to *your* products—and give proof to your customers that you deliver full quantity and quality. When you order drums, specify "Tri-Sure Closures" on your order!

AMERICAN FLANGE & MANUFACTURING CO. INC.
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.
Tri-Sure Products Limited, St. Catharines, Ontario, Can.

*The "Tri-Sure" Trademark is a mark of reliability backed by 30 years serving industry. It tells your customers that genuine Tri-Sure Flanges (inserted with genuine Tri-Sure dies), Plugs and Seals have been used.

Tri-Sure
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CLOSURES

Positive Displacement Meters

. . . of the rotary type, for measuring gases of any type, in quantities from 4,000 to 1,000,000 cfh., at pressures up to 25, 50, and 125 psi. Bulletin M-152 with technical data. Roots - Connersville Blower Div., Dresser Industries, Inc., Connersville, Ind.

Circle No. **43** *on Reply Card*

Welding for Low Temperature

. . . service, an evaluation of the properties of weld metals for this application is featured as a 12-page article in the winter 1953 issue of *Alco Products Review*. American Locomotive Co., Alco Products Div., Schenectady 5, N. Y.

Circle No. **44** *on Reply Card*

For Your Convenience

Business reply cards are included in each issue of PETROLEUM PROCESSING to assist you in obtaining more information on any items reviewed in "What's New!" You'll find them facing the first page of this section. Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the bottom of the card and drop it in the mail. No postage required.

Information Offered in The Advertisements

Do you need detailed information on a specific subject? Check through this easy-to-use index of literature and data offered in this issue's advertisements:

ACTIVATED ALUMINA, as a desiccant: Details; Aluminum Co. of America. See adv't. p. 171.

ADDITIVES, for light oils, for corrosion inhibiting in storage, Santolene C: Information; Monsanto Chemical Co. See adv't p. 199.

ADDITIVES, lube oils, to meet new API and military specifications: Information; Oronite Chemical Co. See adv't p. 161.

ADSORBENTS CATALYSTS, and catalyst carriers: Information; Attapulgus Minerals & Chemicals Corp. See adv't p. 189.

AIR COMPRESSORS: Bulletin L-675-B1B; Worthington Corp. See adv't p. 159.

AIR DRYERS: Information; Pittsburgh Lectrodryer Corp. See adv't p. 186.

AIR PREHEATER: Complete information; The Air Preheater Corp. See adv't p. 192.

ALLOYS, nickel, for high temperature service: High temperature work sheet; The International Nickel Co., Inc. See adv't p. 270.

AUTOMATIC SPRINKLERS, for fire fighting: Literature; Automatic Sprinkler Corp. of America. See adv't p. 268.

CATALYTIC CRACKING UNITS: Booklet S-5 on butylene yield prediction; Filtrol Corp. See adv't p. 200.

CATALYTIC REFORMING: Information on new "Catforming" process; The Atlantic Refining Co. See adv't pps. 168-169.

CHECK VALVES, tilting disc type: Catalog 30; The Chapman Valve Mfg. Co. See adv't p. 256.

CHEMICALS: Complete listing; General Chemical Division of Allied Chemical & Dye Corp. See adv't inside back cover.

CHLORINATION, for slime control: Information; Wallace & Tiernan Co., Inc. See adv't p. 264.

COMPUTING SERVICE, for large-scale data-processing problems: Information; Engineering Research Associates Division of Remington Rand. See adv't pps. 284-285.

CORROSION CONTROL, and bacterial-algae growth reduction: Tech. Bulletin E-6, and samples; Armour & Co. See adv't p. 207.

DESALTING, electrical: Complete information; Petro-chem Development Co. Inc.; See adv't facing p. 240.

ELECTRIC POWER, systems for refineries: Information; Westinghouse Electric Corp. See adv't pps. 204-205.

ENGINEERING CONSULTING SERVICE: Brochure PP-16-1; Arthur D. Little, Inc. See adv't p. 269.

EXPANSION JOINTS: Details; American District Steam Co., Inc. See adv't p. 265.

FILTERS, for finished petroleum products: Bulletin FO-52; Warner Lewis Co. See adv't p. 291.

FITTINGS, valves and pumps, jacketed: Bulletin J-50; Hetherington & Berner Inc. See adv't p. 272.

FITTINGS, weld: Catalog 48; Midwest Piping & Supply Co., Inc. See adv't p. 193.

FITTINGS, welded: Catalog W3; Bonney Forge & Tool Works. See adv't p. 176.

FLAME CUTTER, for salvaging fittings, valves, etc.: Bulletin FC-2; Vernon Tool Co., Ltd. See adv't p. 292.

FOAM, fire fighting: Booklet: What is Foam and how to use it; National Foam System Inc. See adv't p. 262.

FUEL OIL CONDITIONER, for reducing storage tank sludge: Complete details; Wright Chemical Corp. See adv't p. 259.

GAGE, liquid level reading: Truscale catalog; Jerguson Gage & Valve Co. See adv't p. 285.

GAS HOLDERS, dry-seal type: Information; General American Transportation Corp. See adv't p. 203.

GAS SCRUBBER: Bulletin Supplement 4-RA; Schutte and Koerting Co. See adv't p. 208.

GASOLINE DYES: Reference booklet; Du Pont Petroleum Chemicals Division of E. I. Du Pont de Nemours & Co., Inc. See adv't p. 260.

GENERATOR, oxygen-nitrogen: Catalog; Air Products, Inc. See adv't p. 249.

HEAT EXCHANGERS, fin tubed: Bulletin No. 512; Brown Fintube Co. See adv't p. 178.

HEAT EXCHANGER TUBES: Information; The American Brass Co. See adv't p. 182.

HOMOGENIZER, blender, disperser, or emulsifier: Bulletin T-52 "The Turbinizer." The U. S. Stoneware Co. See adv't p. 283.

INDUSTRIAL INSULATION: Booklet; The Philip Carey Mfg. Co. See adv't p. 175.

Which butterfly valve better meets your needs?
In either of these or any other valves, manual or automatic, which W. S. Rockwell builds for your exact needs, you're sure to get the right type and size to best meet the conditions of operating pressure, temperature and nature of fluid handled, whether it be air, gases, water, liquid or semi-solid chemical materials.
It will pay you to learn how Rockwell Valves can meet your plant's flow control requirements.
Rockwell stainless steel valve; with air cylinder operator and valve positioner; for throttling gases at 1200° F.
Rockwell heavy duty valve for 50 p.s.i. working pressure; has a replaceable rubber liner for valve body and stainless steel blade; with a motor operator and handwheel declutching unit.
ROCKWELL Valves
Write for Valve Catalog
W. S. ROCKWELL COMPANY
BUTTERFLY VALVES • SLIDE VALVES • AUTOMATIC VALVES
2533 ELIOT STREET • FAIRFIELD, CONN.

What's New!

INFRARED ANALYZER, for plant streams: Details; Process Controls Division of Baird Associates, Inc. See adv't p. 274.

INHIBITORS, gum, for gasoline: Booklets on Tenamenes; Eastman Chemical Products, Inc. See adv't p. 211.

MIST ELIMINATORS: Bulletins; Metal Textile Corp. See adv't p. 148.

MIST ELIMINATORS, wiremesh: Catalog 13; Otto H. York Co., Inc. See adv't p. 215.

MIXERS, side entering: Catalog on all types; Mixing Equipment Co., Inc. See adv't p. 216.

OIL BURNERS, dual stage: Bulletin 25; National Airoil Burner Co. See adv't p. 284.

PAINT, rust preventative: Complete literature; Rust-Oleum Corp. See adv't p. 183.

PERCO PROCESSES, for refining: Information; Phillips Petroleum Co. See adv't p. 172.

PUMPS, centrifugal: Full information; Oil Well Supply Division of U. S. Steel Corp. See adv't p. 157.

PUMPS, proportioning, Micro-Feeder: Bulletin SM-30052; %Proportioneers, Inc.% See adv't inside front cover.

PUMPS, rotary, positive-displacement: "Facts" booklet; Blackmer Pump Co. See adv't p. 257.

PURIFIER, for steam turbines: Information; The V. D. Anderson Co. See adv't p. 275.

REFINERY VESSELS, towers, drums, tanks, spheres, etc.: Information; Chicago Bridge & Iron Co. See adv't facing p. 241.

REFRACTORY LININGS: Brochure RC-28A; Johns-Manville. See adv't p. 289.

SEALS, mechanical: Dura Seal book; Durametallic Corp. See adv't p. 292.

STEAM TRAPS: 44-page book; Armstrong Machine Works. See adv't pps. 194-195.

STEAM TRAPS, general: Bulletin 152; W. H. Nicholson & Co. See adv't p. 295.

TOWER CLEANING: Details; Oakite Products, Inc. See adv't p. 286.

TUBE CLEANING, and tube expanding: Literature; Airetool Mfg. Co. See adv't p. 263.

TUBING, alloy: Bulletin TB-12; The Babcock & Wilcox Co. See adv't p. 166.

TURBINES, general purpose: Information; Westinghouse Electric Corp. See adv't p. 164.

TURBINES, mechanical-drive: Bulletin GEA-4955A; General Electric Co. See adv't pps. 184-185.

TURBINES, steam pump drives: Full details & specifications; Dean Hill Pump Co. See adv't p. 206.

VALVE ACTUATOR, pneumatic power, gear-driven positioning: Bulletin C-1; Conoflow Corp. See adv't p. 295.

VALVES, automatic control: Bulletin No. 103-a; Hammel-Dahl Co. See adv't p. 170.

VALVES, check: Crane catalog; Crane Co. See adv't p. 162.

VALVES, control: General catalog; The Annin Co. See adv't p. 177.

VALVES, control: Bulletin 700-2; Minneapolis-Honeywell Regulator Co. See adv't p. 253.

VALVES, for pumps: New catalog; Sims Pump Valve Co., Inc. See adv't p. 286.

WASTE WATER CONDITIONING: Bulletin WC-103, also technical paper on economic factors; Graver Water Conditioning Co. See adv't p. 210.

WATER CONDITIONING: Technical paper 123; W. H. & L. D. Betz. See adv't p. 214.

WATER CONDITIONING, to reduce corrosion, scale, and algae: Information; Wright Chemical Corp. See adv't p. 259.

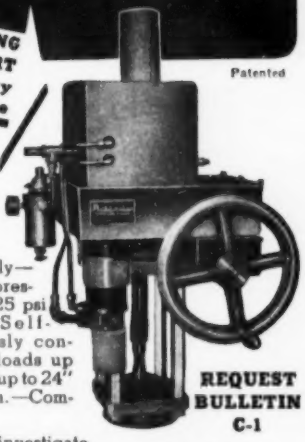
NEW! GEAR-DRIVEN PNEUMATIC OPERATOR FOR THROTTLING CONTROL SERVICE

Rotomotor

PNEUMATIC POWER POSITIONING OPERATOR

ACCURATE POSITIONING TO WITHIN 1/500th PART of STEM TRAVEL on Heavy Duty Throttling Service

Patented



A wholly new and different valve operator employing a reversible pneumatic motor and a precision gear driven screw stem, with these AMAZING advantages:

Operates on 100 psi supply—Sensitivity to instrument pressure changes as small as .025 psi—Perfect stability—Self-locking stem—Continuously connected handwheel—Stem loads up to 40,000 lbs.—Stem travels up to 24" Stem speeds up to 36" p.m.—Compact design.

So different, you will want to investigate its possibilities immediately.

REQUEST BULLETIN C-1

Conoflow Controls

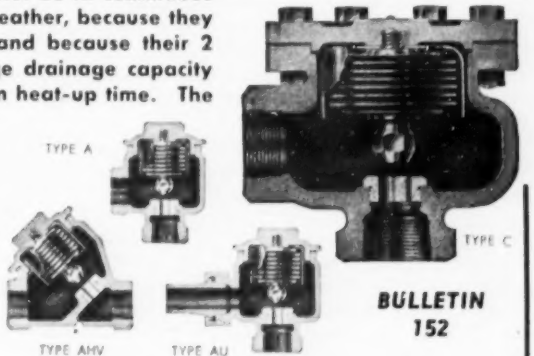
CONOFLOW CORPORATION
2100 Arch St., Phila. 3, Pa.

NICHOLSON MAKES

Freeze-Proof Steam Traps

for Every Plant Use

Because they drain completely when cold, these four types of Nicholson steam traps are positively freeze-proof. Can be freely installed outdoors. Universally recommended for use in lines which need not be in continuous use during cold weather, because they are freeze-proof and because their 2 to 6 times average drainage capacity results in minimum heat-up time. The non-air-binding feature of Nicholson traps also notably facilitates heat transfer in severe weather. Sizes ¼" to 2"; pressures to 250 lbs.



BULLETIN 152

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EDITORIALS

To the Defense of Industry

Dr. Robert E. Wilson, chairman of the board, Standard Oil Co. (Indiana) has stepped outside the conventional role of the scientist and business administrator, and has taken up the cudgel publicly to present the Federal Trade Commission in its true light of distorting the facts about business and "degenerating into an agency of anti business propaganda."

This is an article in the Jan. 24th *Saturday Evening Post* entitled "We, the Accused". Dr. Wilson answers some of the charges made by the Commission, namely, that through interlocking directorates the larger business firms are stifling competition in this country, and that "through waves of mergers" and the concentration of industry in a few companies, the same end of stifling competition is being achieved. He makes a vigorous factual presentation, not limited to the experience of his own company, to show how the Commission has wilfully distorted the truth.

It is a sorry comment on some of our government agencies that they have operated the last 20 years to put industry in an untrue and unfavorable light before the public. Not every scientist in industry can present his case as effectively as Dr. Wilson in the matter of the FTC's charges. In the wider role that scientists are now assuming, every man who believes in his industry should come to its defense with the facts when false charges are made, by whatever means of reply are available to him.

—V.B.G.

More Amateurs in the Act

The Council of State Governments has proposed that the states individually enact laws giving them wide authority over industrial plants and installations in the interests of public safety. The so-called enabling acts would make a state agency responsible for promulgating and enforcing safety codes covering all types of materials that may create public hazards if improperly stored, handled, transported and utilized. Oil company plants, including refineries, though not specifically named, would come within this broad classification.

The current proposal is not the first effort by the states to move in on the established regulatory powers of local governing bodies affecting the petroleum industry. Early in the days of the industry, laws calling for inspection of kerosine were passed by most states, "in the interest of public safety". The inspection of the material by state agents was always a farce, but the states collected an inspection fee on each barrel of kerosine refiners moved inside their borders. The kerosine inspection laws are still on the books in many states and in many cases they have been amended to include gasoline. They are a material source of revenue to the states.

The oil industry has been confronted with other state proposals to impose regulations that would create jobs for additional sets of state agents, duplicate the work done by other authorities and interfere with the efforts of better qualified groups on the specific problems involved. The current proposal for state-wide safety codes is such an effort on a grand scale, covering all industries handling materials subject to the arbitrary definition of creating hazards to public safety.

In the petroleum refineries and distributing plants, safety measures adopted depend inherently on the size of the installation, volume and nature of the products handled and on conditions in the neighborhood. Oil company officials and fire departments and other local agencies are continually working to lessen local public hazards. The industry's fire and safety record is proof of the success of this effort. A state-wide code could hardly be applied without modification or else imposing severe and undue hardship in the individual case.

In general, the safety and fire protection measures adopted by the oil companies are constantly being studied and improved by groups which include industry representatives and those of such technical agencies as the National Safety Council, National Fire Protection Assn., National Board of Fire Underwriters and others. The industry's material and equipment is subject to constant review, to the end of improving safety and other standards, by committees of technologists from the oil companies and equipment manufacturers, sponsored by national technical associations. Their recommendations, as put into effect by the oil companies, are generally out ahead of any codes adopted into federal or state laws.

The proposed model enabling act for state-wide safety codes is an effort by the state governments to extend their authority, and put political appointees into a field where they could only serve to meddle with the efforts of better experienced and qualified authorities. If introduced in the individual states, such bills should have the opposition of the petroleum industry particularly.

—V.B.G.

Welcome, the Electrical Engineer

To the active groups of refinery technologists with training and experience in specialized fields we must now add the electrical engineer. His numbers in the ranks of the oil companies are still limited when compared with other branches of engineering, but the rapid extension of the use of electric power in refineries is rapidly creating new jobs for more of his kind. The cooperative work on behalf of the petroleum industry by electrical engineers is already substantial.

A sub-committee on electrical equipment of the API Refining Division's Equipment Committee is at work on a code covering requirements for standard electrical equipment in refineries. In other fields such codes have proved useful to both the industry and equipment manufacturers. In California, electrical engineers, working with the Western Oil & Gas Assn., secured in a state code important amendments to the National Electrical Code recognizing conditions peculiar to petroleum processing plants there.

The future should find the electrical engineer taking an increasingly important place in technical refinery problems, and also in economic matters where the use of different kinds of power is being considered.

—V.B.G.

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Acid Fluoboric	●	●		●			●	●	●	●	●	●	●			●					
Acid Hydrofluoric, Reagent		●		●			●			●	●										
Alkali Fluoborates							●	●		●	●										
Aluminum Chloride, Solution		●	●			●	●		●	●	●	●	●	●		●	●	●	●	●	
Aluminum Fluoride, Crystal		●								●		●	●								
Aluminum Nitrate		●		●								●							●		
Ammonium Acetate						●				●		●	●				●		●		
Ammonium Oxalate			●		●				●	●			●	●		●	●		●		
Ammonium Sulfate Purified and Reagent A.C.S.	●	●				●	●		●	●				●		●	●		●		
Ammonium Thiosulfate				●					●	●				●	●				●		
Boron Trifluoride Gas and Various Complexes		●								●	●	●	●	●		●		●	●		
Cadmium Nitrate	●	●		●			●					●	●			●					
Calcium Acetate Purified and Reagent		●				●							●	●		●		●	●		
Calcium Chloride, Anhydrous Purified and Reagent A.C.S.				●		●										●					
Calcium Phosphide					●						●										
Chlorine Trifluoride		●														●					
Chromium Fluoride		●	●							●			●							●	
Chromium Nitrate		●														●					
Chromium Potassium Sulfate (Chrome Alum)		●	●						●				○	○			●			●	
Cupric Nitrate		●	●		●			●		●				●						●	
Cuprous Chloride	●	●	●		●						●	●	●	●		●				●	
Ferric Nitrate			●						●											●	
Ferrous Ammonium Sulfate		●	●							●							●				
Lead Nitrate		●	●		●				●		●	●	●	●	●		●		●	●	
Metal Fluoborates										●						●					
Oxamide					●																
Potassium Acetate		●		●					●	●				●		●	●			●	
Potassium Bifluoride		●		●			●			●										●	
Potassium Borate, Tetra										●											
Potassium Fluoride		●								●											
Potassium Nitrite		●	●			●				●		●					●	●			
Potassium Permanganate																					●
Potassium Titanium Fluoride											●						●				
Sodium Bisulfite, Meta Purified and Reagent						●									●					●	
Sodium Fluoride, Reagent A.C.S.								●						●							
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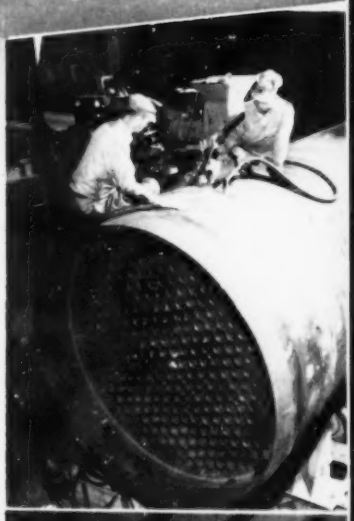

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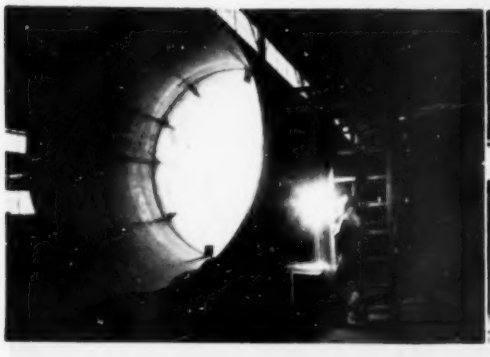

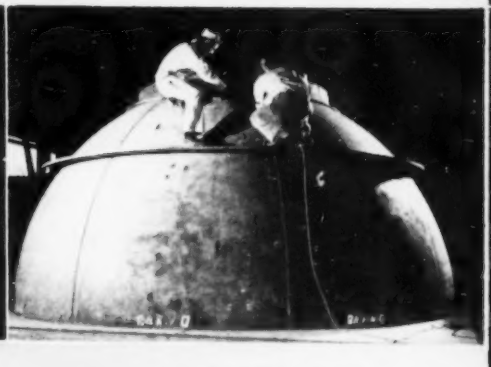

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